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Final Technical Report
October 1980

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AUTOMATED AIR INFORMATION PRODUCTION SYSTEM-PHASE II

Synectics Corporation

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ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
Griffiss Air Force Base, New York 13441

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This report details efforts in providing a fully automated Air Information Production System (AAIPS) for the Defense Mapping Agency Aerospace Center. The system is used to produce DOD Flight Information Publication (FLIPS); Navigation/Planning and Special Purpose Charts; Special Products; and the Automated Air Facility Information File. The requirements, functional design and operational considerations of the AAIPS Charting, Air Facilities, and Publishing Subsystems are presented. (Cont'd)

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The principal purpose of the three subsystems is the reduction of the labor (manual) required for the revision and republication of information critical to flight operations and logistical planning. Improvement of response time between receipt of changes to air navigation/air facilities data and the dissemination of new data to all users, is also provided. The Publishing Subsystem permits publications to be produced on electronic equipment and extends the power and flexibility of digital manipulation to the updating and reformatting of publications. The Air Facilities Subsystem provides maintenance of the AAFIF data bases, selective data base retrieval, special report generation and generation of formatted tape files for film negative output. The Charting Subsystem provides capture, revision and output of graphic data appearing throughout the DMAAC Flight Information Publications, through preservation and alteration of data in digital form.

TABLE OF CONTENTS

TABLE OF CONTENTS - Continued

LIST OF FIGURES

LIST OF TABLES

Evaluation

The Automated Air Information Production System (AAIPS) is being integrated into the production environment of the Defense Mapping Agency Aerospace Center's Aeronautical Information Department (DMAAC/AD) in a phased manner. The first phase involved a total system design with implementation of a pilot system to prove system design concepts and operational software. Successful testing of the pilot system showed that AAIPS would be able to meet the strict schedules imposed on production of Flight Information Publications.

During the second phase of the contract, the pilot system was analyzed to determine its shortcomings and the original design plan was revised to keep the system up to the state-of-the-art and to improve its production capabilities. The resulting system provides the DMAAC/Aeronautical Department with a very effective up-to-date production system capable of being easily enhanced to meet future production requirements.

John R Baumann

JOHN R. BAUMANN
Project Engineer

SECTION 1. INTRODUCTION

1.1 GENERAL

This is the final Technical Report, Automated Air Information Production System (AAIPS), Rome Air Development Center Contract Number F30602-77-C-0065. This report is submitted as required by Contract CDRL Item 001 Attachment 6 and has been prepared in accordance with Data Item Description DI-S-3591A/M, MIL-STD-847A, and other pertinent directives.

1.1.1 Background

The Aeronautical Information Department (AD) of the Defense Mapping Agency Aerospace Center (DMAAC) is responsible for the acquisition, maintenance evaluation, and exploitation of aeronautical information to support Defense Mapping Agency (DMA) Aerospace Charts and Flight Information Publications (FLIPS) distributed worldwide. This information is provided to the Department of Defense (DoD) and other agencies and authorized users for flight operations and logistical planning purposes.

The major AD production programs include:

a. DoD Flight Information Publications (FLIPS);

b. Navigation/Planning and Special Purpose Charts;

c. Special Products; and

d. Automated Air Facility Information File (AAFIF).

1.1.2 Flight Information Publications

FLIPS produced are associated with Alaska, Pacific Australasia Anaractica, Canada North Atlantic, United States, Caribbean South America, Europe North Africa Middle East, and Africa. The general types of FLIPS are:

a. planning documents;

b. enroute charts and supplements; and

c. terminal procedures.

1.1.2.1 Planning Documents

The eight separate planning documents consist of pre-flight planning information such as standard terms/abbreviations, meteorological data, pilot procedures, special use air space, parachute jumping areas, and military training routes.

Collectively the planning documents consist of about 50,000 lines of text; over 5 million characters of information. They undergo about 3,500 update transactions (representing 37,500 text line changes) per year.

1.1.2.2 Enroute Charts and Supplements

These publications consist of 91 flight chart and six textual supplements; they typically contain such information as airway system/special use air space, aerodrome data, and navigational facilities. Objectively, the enroute supplements contain 140,000 lines of text; almost 11 million characters of information, and undergo nearly 45,000 update transactions representing over 62,000 lines of text changes. The enroute charts, produced in large graphic format, typically require over 800 changes per year. Contents of the publications vary.

Enroute Supplements for Foreign Areas contain sketches of selected aerodromes and heliports as well as text. The IFR Enroute Supplement US is essentially textual with no aerodrome sketches. The VFR Supplement US contains aerodrome sketches with supporting text of military and general aviation aerodromes.

1.1.2.3 Terminal Procedures

The publications are standardized graphics illustrating predetermined maneuvers for runway approaches and landings and instrument meteorological conditions. There are three basic types of Terminal Procedures.

There are approximately 2,900 Instrument Approach Procedures (IAPs) which undergo over 4,500 changes annually. The near 1,350 Standard Instrument Departures (SIDs) are maintained with about 1,500 changes per year. The approximately 550 Terminal Charts are supported by over 1,600 updates made each year.

1.1.2.4 FLIP Production Cycles

The FLIP annual production is broken down into five (5) categories; the semi-annual, 84-112 days, 56 days, 28-56 days, and monthly revisions.

1.1.3 Navigation/Planning/Special Purpose Charts

These charts require selected overprint data (portrayed by symbolization with textual description) regarding such aeronautical information as airfields, electronic navigation aids, and special-use air space. The annual workload for the aeronautical overprints is nearly 1000 compilations/revisions per year. The types of charts and their associated product scales are as follows:

a. Tactical Pilotage Chart 1:500,000;

b. Operational Navigation Chart 1:1,000,000;

c. Jet Navigation Chart 1:2,000,000; and

d. Global Navigation/Planning Chart 1:5,000,000.

1.1.4 Aeronautical Information Special Products

The three types of special products are:

a. Aeronautical Video Mapping;

b. Tactical Situation Displays; and

c. Airfield Diagrams.

1.1.5 Automated Air Facilities Information File (AAFIF)

AAFIF is an automated file of evaluated information pertaining to all foreign free world airways. AAFIF currently maintains approximately 45,000 airfield records; daily information updates number about 2,000. The over 400 million characters comprising AAFIF reside on 21 reels of magnetic tape. AAFIF informational content is categorized as follows:

a. General Identification and Description;

b. Operational Users;

c. Navigation Aids and Communications;

d. Airfield Description;

e. Maintenance and Servicing;

f. Special Purpose Equipment Base Services; and

g. Transportation/Weather.

Outputs derived from AAFIF source information are recorded on magnetic tape or printed. Approximately 90 different products constitute the scheduled production; roughly one-third in digital tape form and the remainder as hardcopy printed reports. Scheduled product users are:

a. Defense Intelligence Agency (DIA);

b. World Wide Military Command and Control System (WWMCCS); and

c. Other US Government Agencies.

Yearly production of magnetic tapes averages 800; the weekly average is 15 with weekly peak loads as high as 100. Average annual volume of hardcopy printed material is 700,000 pages; the weekly average is 13,000 with typical weekly peak loads amounting to 80,000.

1.2 PURPOSE

The Automated Air Information Production System (AAIPS) has been implemented by Synectics Corporation under contract to Rome Air Development Center (RADC) for the Defense Mapping Agency Aerospace Center (DMAAC). The scope of this effort encompassed the analysis, design, specification, implementation, and test and evaluation of all hardware and software components of the various subsystems of AAIPS.

This is the final report marking the completion of all work performed during Phase II of the AAIPS system development program.

1.3 PHASE I SUMMARY

Phase I of the AAIPS Program required the development of a baseline design for the total system and the implementation of a PILOT system.

The scope of the Phase I effort encompassed the analysis, design, and specification of all hardware and software components comprising a three subsystem AAIPS concept. The PILOT system development included the acquisition and integration of hardware components and all custom software necessary to successfully demonstrate the capability

to manage and process 1/15th of the normal FLIP/AAFIF workflow. This level of system performance constituted the major evaluation criteria for determination of whether to pursue the total system development during Phase II of the AAIPS program.

The Phase I effort also called for a complete redesign of the Automated Air Facilities Information File (AAFIF) to eliminate redundancy and wasted storage capacity.

The AAIPS system functional configuration was comprised of three subsystems known as the Publishing Subsystem, the Charting Subsystem, and the Air Facilities Subsystem. Collectively these subsystems accomplish the automated production workload of all Flight Information Publications (FLIPs) and the Automated Air Facilities Information File (AAFIF) as described in Section 2 of this report.

Each subsystem outputs to a device associated with the Charting Subsystem which, in turn, is capable of supporting the creation of composite ready-for-reproduction film negatives using existing production equipment. The subsystems provide an extensive machine-editing capability for data entry and revision.

The principal purpose of the AAIPS is to reduce the labor required (by manual methods) for the revision and republication of information critical to flight operations and logistical planning, in view of the anticipated growth of both the types and volumes of information. A by-product of that labor reduction is the improvement of response time between receipt of changes to air navigation/air facilities data and the dissemination of new data to end users.

The test and acceptance of the PILOT AAIPS required the development of a comprehensive test plan, which provided the guidelines for the achievement of the system goals and objectives traceable to the original statement of work (SOW). The procedures for testing ensured that all requirements would be demonstrated and sufficient data would be collected for reasonable evaluation. Verification of the original total system design and identification of necessary design modifications were the implicit results of the test and evaluation.

The test objectives for each AAIPS subsystem were to (1) demonstrate that hardware/software and firmware capabilities supplied by vendors performed correctly and met the SOW specifications, (2) all subsystem functions performed in a manner such that the results and procedures matched or exceeded the SOW requirements, and (3) the functions and inter-subsystem processes could execute properly and perform satisfactorily with the 1/15th data volume. Tests for each subsystem were either designed for inspection of operational or non-operational hardware characteristics; functional performance of hardware, software, and operational procedures; and volume throughput performance.

The PILOT AAIPS as developed, implemented, and tested at the Defense Mapping Agency Aerospace Center (DMAAC) Aeronautical Information Department (AD) successfully met the performance requirements and was accepted. Based on the evaluation of the test and acceptance results the following conclusions were drawn from the Phase I PILOT system development experience.

a. The concept of independent subsystems with independent product-oriented data bases proved to be very practical and efficient in supporting production activity.

b. The products derived from the pilot data bases met or exceeded the product quality specifications used at the Aeronautical Department.

c. The maintenance of the product data bases by means of the on-line revision functions developed for the PILOT subsystem proved to be much more efficient than anticipated.

d. The operational procedures that were iteratively refined throughout Phase I successfully supported system throughput, but improvements in this area would be extremely important to assure successful total integration of AAIPS into the AD environment during the Phase II effort.

e. The hardware selected proved to be responsive to the FLIP production requirements and was well-received by AD personnel who had hands-on experience during the pilot data base creation and test period. All hardware was off-the-shelf and met or exceeded the reliability and maintainability requirements in the SOW.

The AAIPS PILOT system was clearly a success. However, definite items for improvement during Phase II were detected from evaluation of the test results. These items were subsequently included in the Phase II development plan.

1.4 REPORT ORGANIZATION

This report is self-contained in one volume. It encompasses the AAIPS System Overview-Phase II, Training, Test and Evaluation, and Conclusions and Recommendations.

SECTION 2. AAIPS SYSTEM OVERVIEW

2.1 OVERALL REQUIREMENTS/CAPABILITIES

The AAIPS system involves a functional configuration comprised of three subsystems known as the Publishing subsystem, the Air Facility subsystem, and the Charting subsystem. These subsystems accomplish the automated production workload of all Flight Information Products (FLIPs) and the Automated Air Facilities Information File (AAFIF) as described in Section 1 of this report (Figure 2-1).

The principal purpose of all three subsystems of AAIPS is the reduction of the labor required (by manual methods) for the revision and republication of information critical to flight operations and logistical planning, in view of the anticipated growth of both types and volumes of information. A by-product of that reduction of labor is the improvement of response time between receipt of changes to air navigation/air facilities data and the dissemination of the new data to all users.

There are eight overall system requirements. Each subsystem outputs to a device associated with the Charting Subsystem which, in turn, is capable of supporting the creation of composite ready-for-production film negatives using existing production equipment. The subsystems provide an extensive machine-editing capability at the time and place of data entry to allow for operator notification of invalid data rejection. A restart capability which protects against data loss and allows the restart of all jobs is also provided on each subsystem. The subsystems accept and output codified data in ASCII code.

The System Security requirements are provided as explained below. Remote terminal users are required to prove their authorizations before obtaining access to the system. The supervisory console restricts access with its disabling/enabling control over remote terminals. Irregular log-on procedures resulting in access denial are automatically accounted for and recorded. Appropriate security markings are appended to all hardcopy reports and softcopy displays regarding classified information.

2.2 OPERATIONAL ENVIRONMENT

The AAIPS system operational environment manifests itself in three tangible perspectives: operational procedures; hardware environment; and personnel functions. The overall functional framework implemented

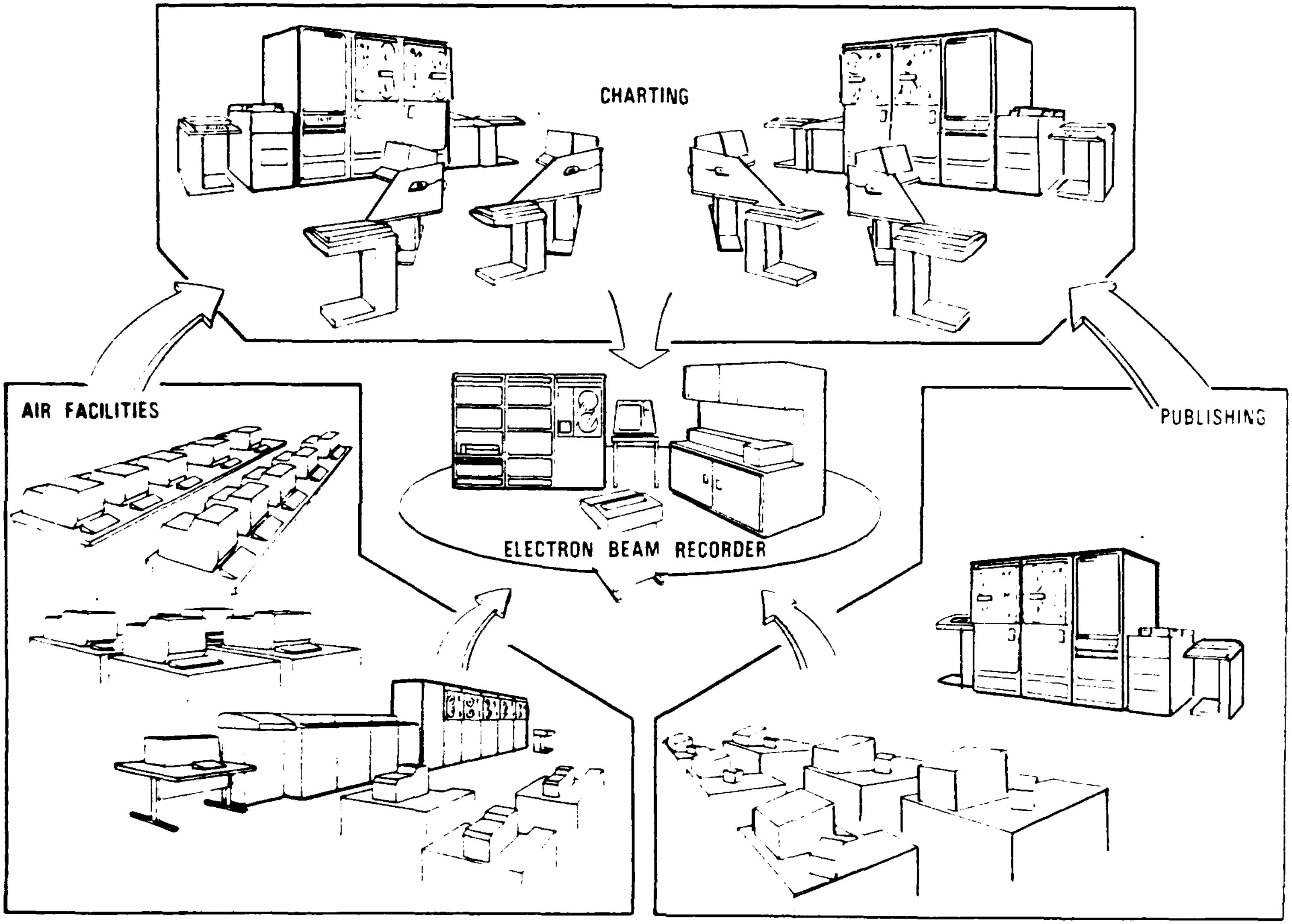

Figure 2-1. Automated Air Information Production System

for the AAIPS is integrated within the AD environment as illustrated in Figure 2-2. The Automation Division assumes the responsibility for the management of the AAIPS production environment.

2.2.1 Operational Procedures

The operational procedures within the Aeronautical Department have undergone several changes with the addition of the Charting, Air Facilities, and Publishing subsystems. These changes are necessary to provide for a smooth integration of the AAIPS into the current organizational structure. The details of these procedures are listed in subsequent sections of this report. It is projected that the operational procedures will be refined, on a continual basis, at some point where they are deemed optimum.

2.2.2 Hardware

The AAIPS concept is a three subsystem concept. Each subsystem is basically independent; therefore only hardware compatibility not dependency is required.

The Air Facilities subsystem hardware configuration (reference Figure 2-3) is comprised of a Data General Corporation ECLIPSE M-600 processor with 256K words of MOS/ERCC memory, 8-192 Mbyte disk drives supported by 2 disk subsystem controllers, a 2 Mbyte fixed head disk and controller, a 16 asynchronous line multiplexor, 2-9 track 75 ips 800/1600 bpi magnetic tape drives and controller, 1-9 track 75 ips 800 bpi magnetic tape drive and controller, a 7 track 75 ips 800 bpi magnetic tape slave drive, 1-600 lpm line printer subsystem, 1-60 cps Dasher printer/keyboard, 1 Decision Data Model 8010 interpreting data recorder and controller capable of punching 75 cpm and reading 200 cpm, 16 Datagraphix Model 132B Alphanumeric CRT terminals, 2 Gandalf Data Inc. Model LDS 250/3 56 Kbps synchronous short haul modems, 2 General Data Comm Industries TDM-1205 time division multiplexors, and 2 Government furnished KG-34 encrypt/decrypt units and Mosler safes.

The Publishing subsystem hardware configuration (reference Figure 2-4) comprised of a Data General Corporation ECLIPSE C-330 processor with 128K words of core memory, a 4 line asynchronous line multiplexor, a 436 lpm (upper and lower case) lineprinter, 1-192 Mbyte disk subsystem (controller and drive), 1-9 track 45 ips 1600 bpi magnetic tape drive and controller, 1-9 track 75 ips 800/1600 bpi magnetic tape drive and controller, 2 Datagraphix Model 132-A CRT display terminals with special characters, and 2 Informer Model V301 CRT monitors and controllers.

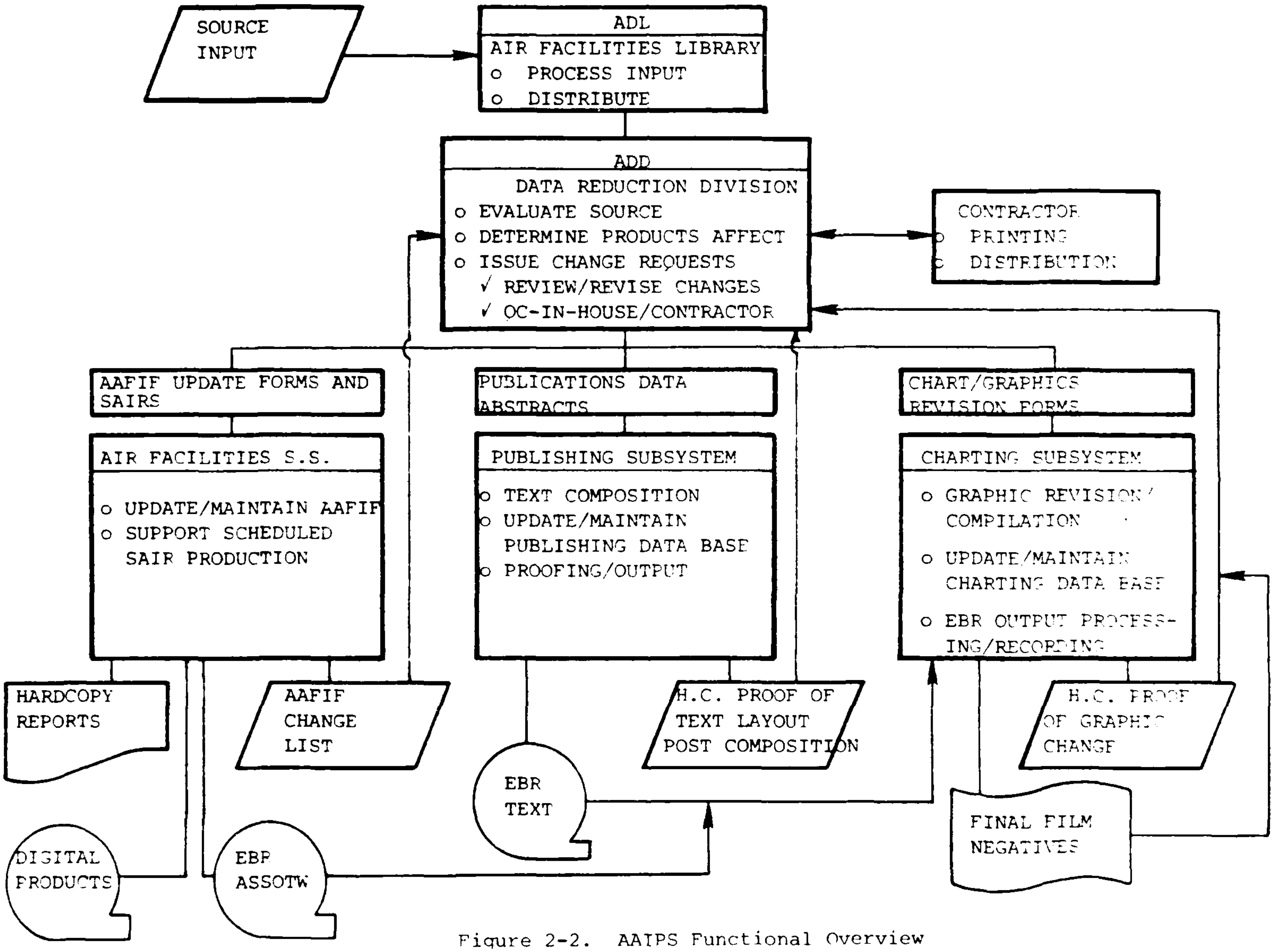

Figure 2-2. AAIPS Functional Overview

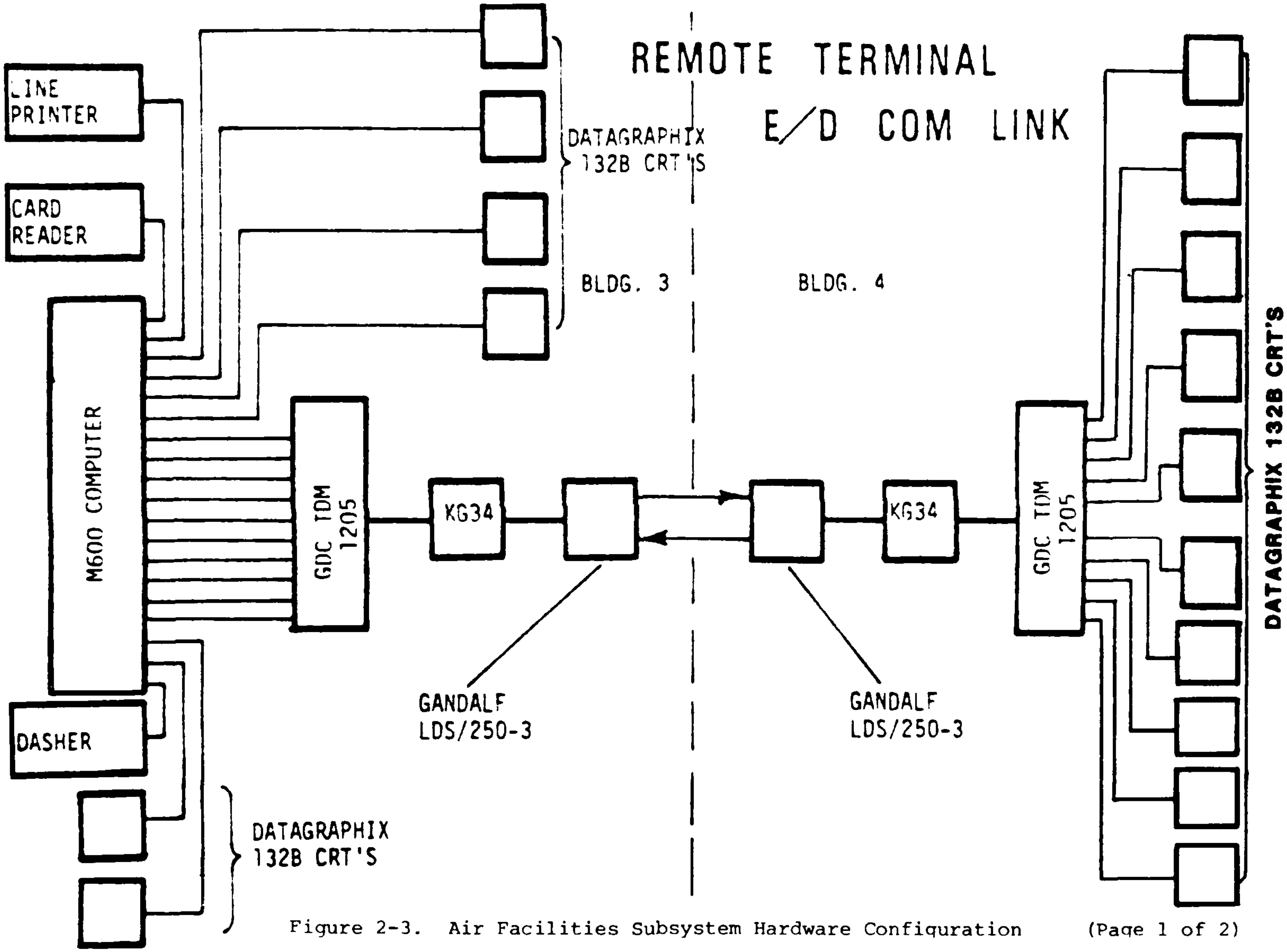

Figure 2-3. Air Facilities Subsystem Hardware Configuration (Page 1 of 2)

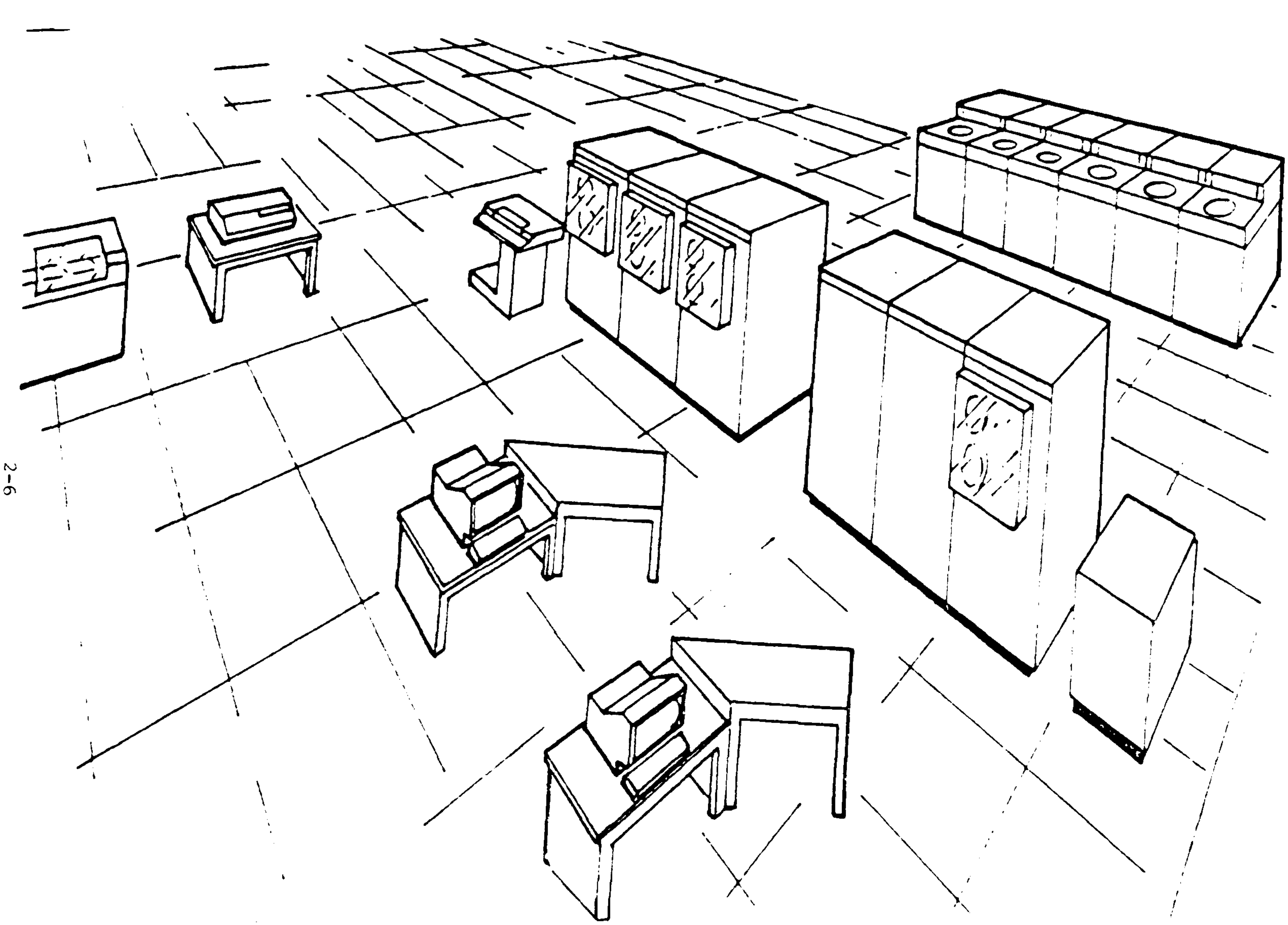

Figure 2-3. Air Facilities Subsystem Hardware Configuration (Page 2 of 2)

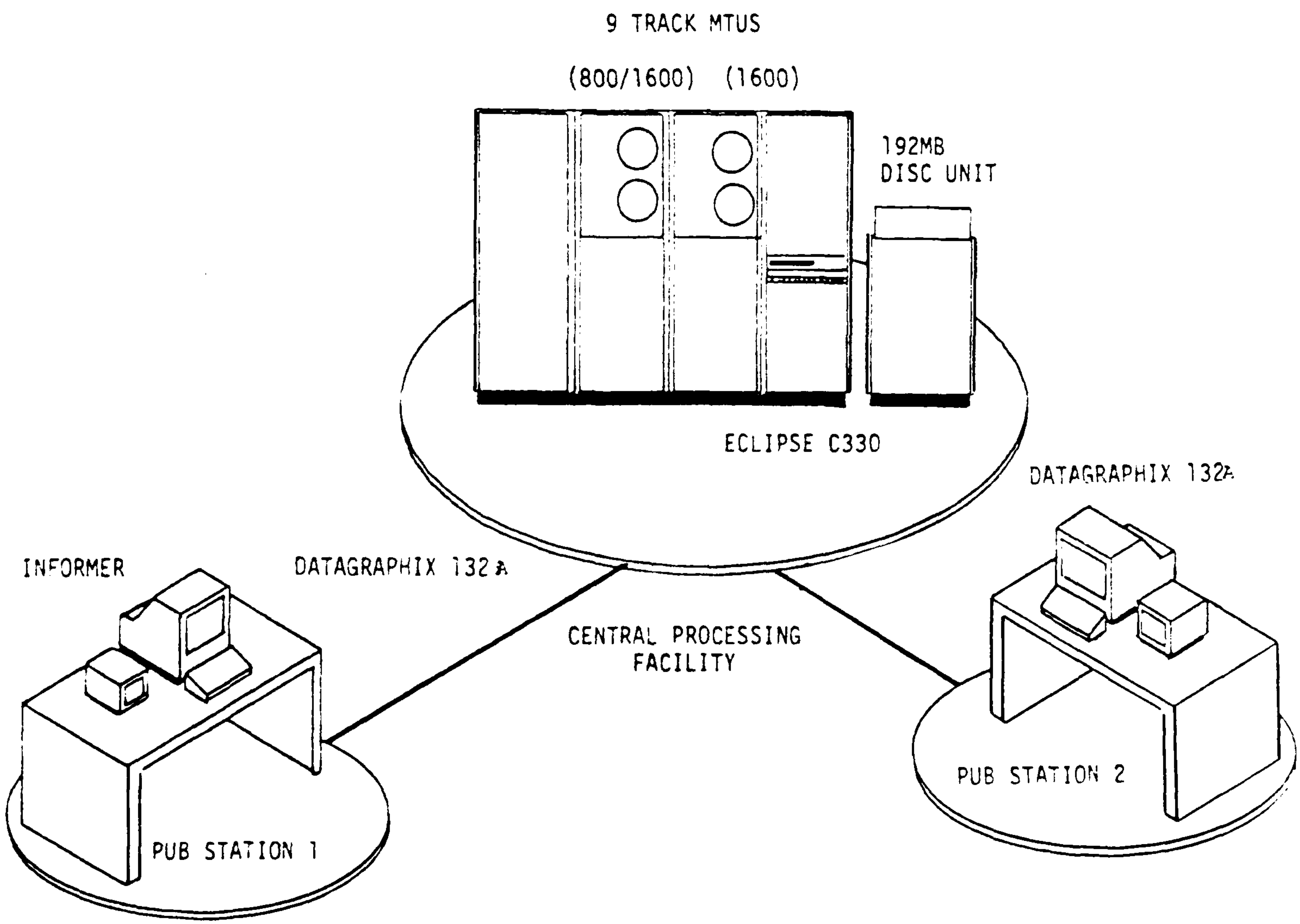

Figure 2-4. Publishing Subsystem Hardware Configuration

The Charting Subsystem hardware configuration (reference Figure 2-5) is a dual workstation concept supported by two Data General Corporation ECLIPSE S-230 processors each with 80K words of core memory. Associated with each ECLIPSE S-230 processor is a 192 Mbyte disk drive and controller, 1 Datagraphix Model 132B CRT display terminal with special characters, 2-60 cps Dasher terminal printer/keyboards, 2 Textronix 4014-1 graphic storage CRT displays, 1 Textronix 4631 hardcopy unit multiplexed to the two graphic CRTS, and 2 Data Automation Corporation Absolute digitizers with 60" X 42" active table surface area and 16 key free-moving cursor. Associated with one S-230 processor are 2-9 track 75 ips 800 bpi magnetic tape drives and controller. The other S-230 processor has 2 9 track 75 ips 800/1600 bpi magnetic tape drives and controller.

The Charting subsystem output device (reference Figure 2-6) is an Image Graphics, Inc. AAIPS Cartographic Series 2000 Electron Beam Recorder (EBR). The EBR is supported by a PDP-11/34T processor with 64K words of core memory, 2.5M words of removable RK05 disk drives, 1-9 track 800/1600 bpi magnetic tape drive and controller, 1 TEKTRONIX-619 graphic CRT monitor, and a symbol/vector generator.

2.2.3 Personnel

Some personnel changes have taken place in the production environment. The extent of change and functional realignment for the AAIPS production environment will not change the current lines of responsibility and authority within the AD organization. The ultimate source of authority and responsibility over the correctness of the FLIP products and accuracy of the AAFIF information rests entirely with the Aeronautical Information Specialist in AD.

2.3 SUBSYSTEM SUMMARY

The principal purpose of all three subsystems of AAIPS is the reduction of the labor required (by manual methods) for the revision and republication of information critical to flight operations and logistical planning, in view of the anticipated growth of both types of volumes of information. A by-product of that reduction of labor is the improvement of response time between receipt of changes to air navigation/air facilities data and the dissemination of the new data to all users.

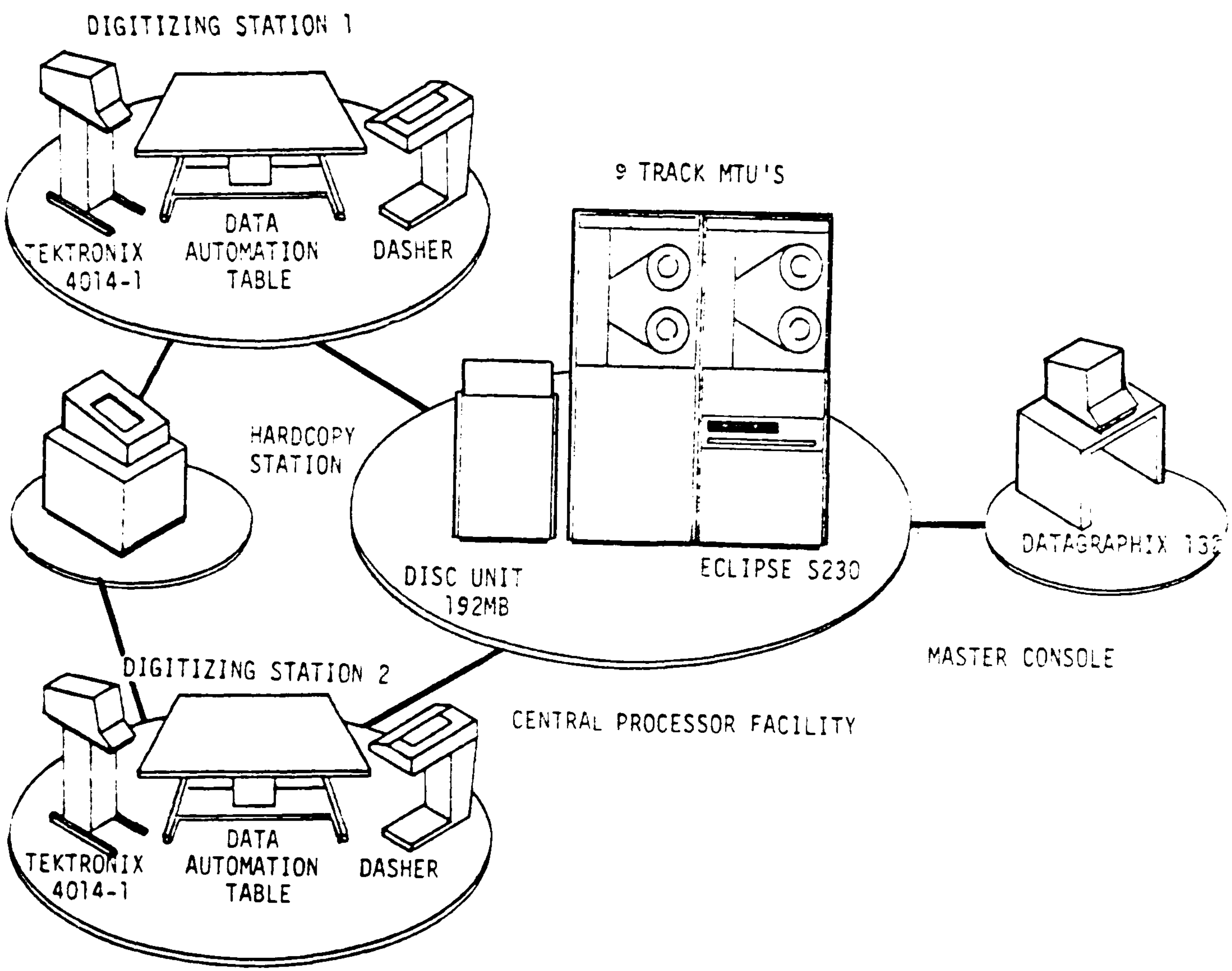

Figure 2-5. Charting Subsystem Hardware Configuration

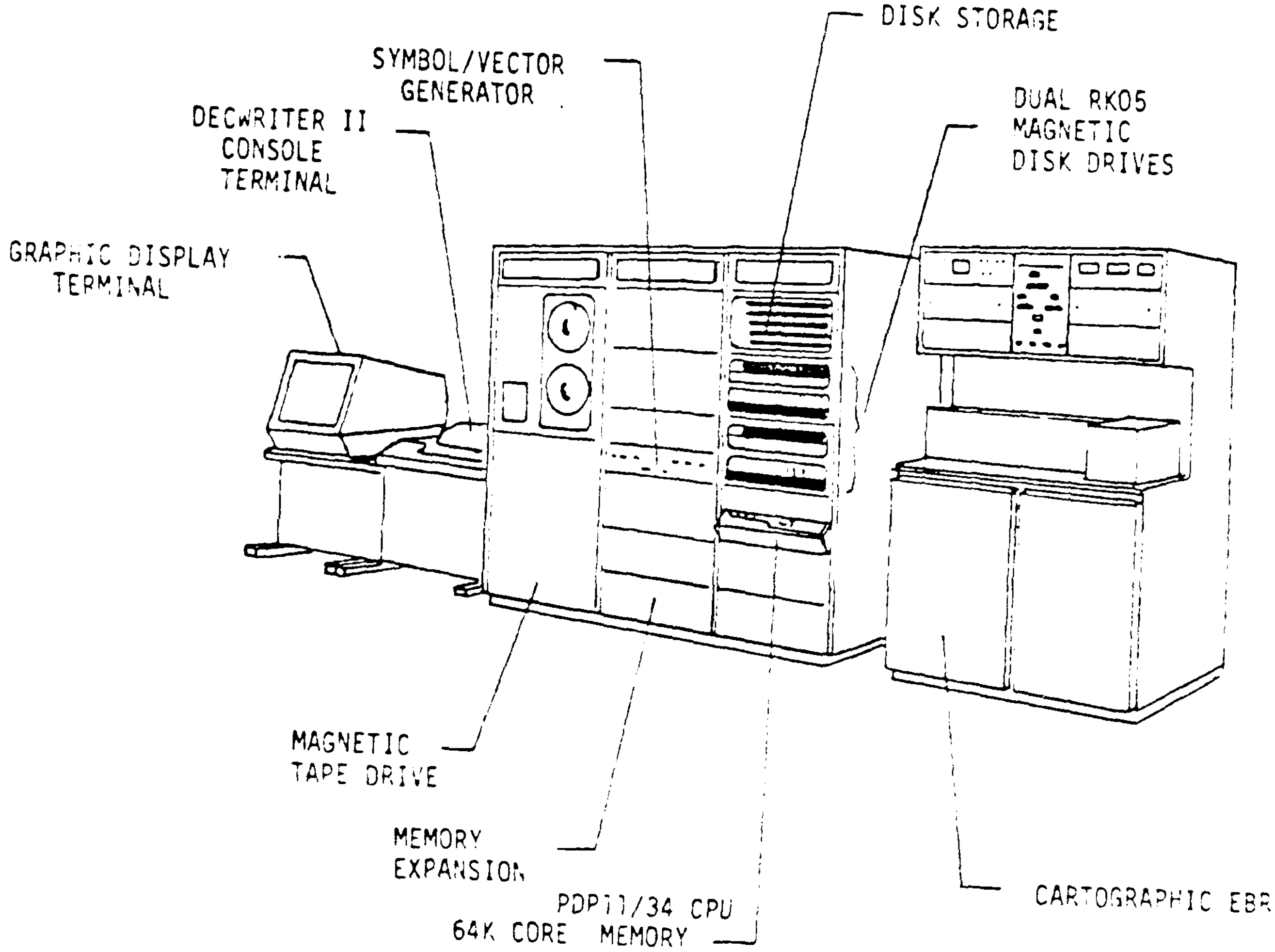

Figure 2-6. AAIPS EBR System Configuration

2.3.1 Publishing

The purpose of the DMAAC Publishing Subsystem is to permit the publications to be produced on modern electronic equipment, extend the power and flexibility of digital manipulation to the updating and reformatting of the publications, and reduce the manpower required to produce the publications.

The DMAAC Publishing Subsystem is designed to create and maintain complex flight information publications (FLIPs) used by military pilots all over the world. The major functional areas are: log-on/log-off, publication identification and creation, display manipulation, update pages, file management, publication reports and statistics, repagination and output to EBR, and publication proofing. Figure 2-7 depicts the overall functionality of the Publishing Subsystem.

The Aeronautical Information Department (AD) of DMAAC publishes flight and air facilities information. These publications are used by DoD agencies, U.S. Commands, military services, and other authorized users for flight operations and logistical planning. These publications result in about 140 issues and 1.5 million lines of text per year with a 50% annual character change rate. The data base structure of the Publishing Subsystem is designed to accomodate that data necessary for the production of the publications as well as the ready access and maintenance of the data.

The Publishing Subsystem provides a well human engineered, cost-effective, high-quality replacement of the manual document-to-tub file-to-varitype-to-tub file-to-camera system it replaces. The subsystem avoids extensive training, excessive errors, operator frustration, and production delays. Continuity of update sessions is insured. The subsystem is a flexible and responsive tool that is highly automatic. Additional requirements are high-quality control through system proofing aids and reports, the ability to distinguish symbology in update mode, comprehensive error diagnostics, flexible error correction procedures, and dependable automated assistance.

2.3.1.1 Capabilities

The Publishing system as developed possess many unique advantages over existing systems, be they of word processing or typesetting origin.

a. Utilization of a CRT which displays 3960 characters of text at once (132 X 30).

b. On-line hyphenation and justification of typesetting quality.

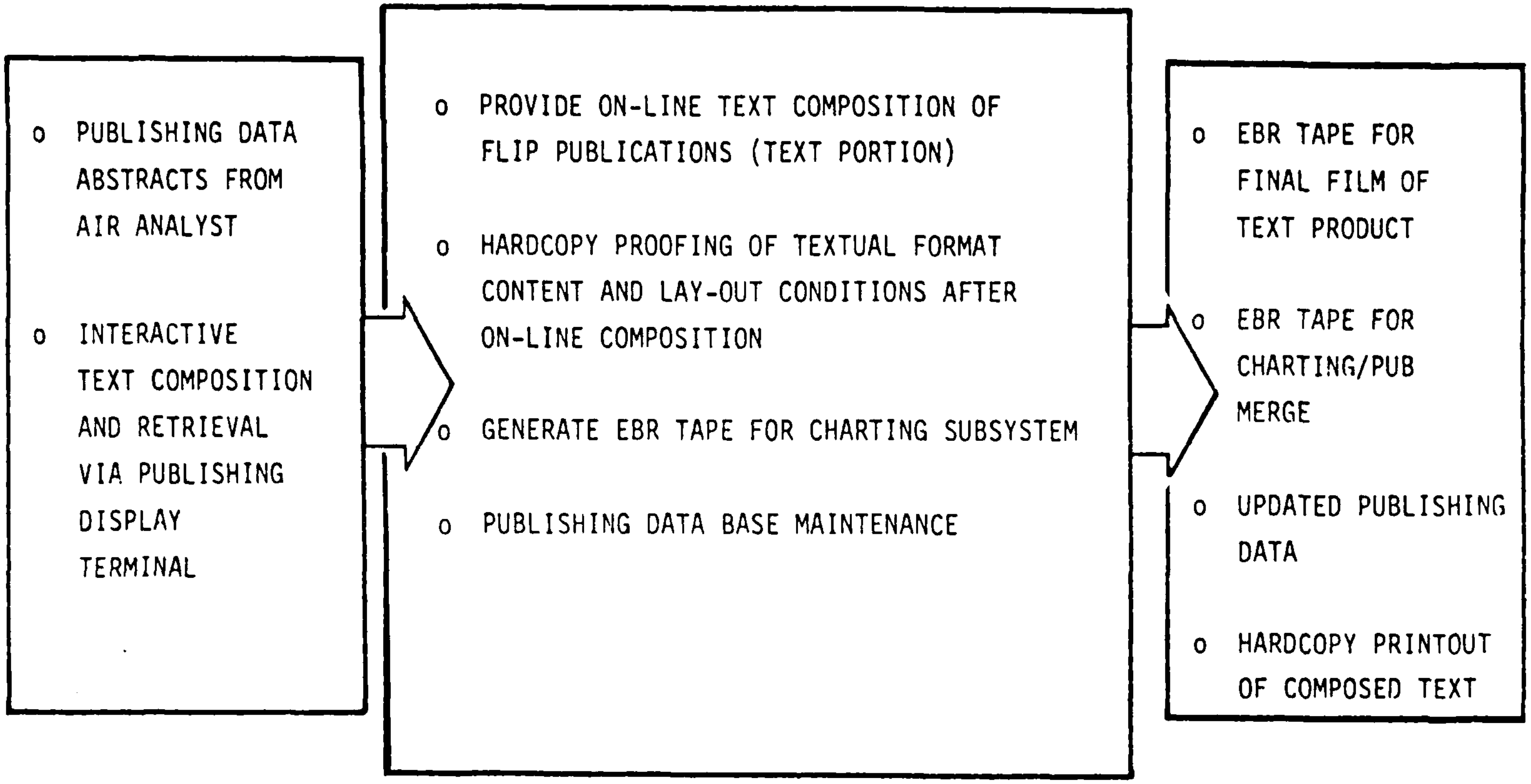

Figure 2-7. Publishing Subsystem Functional Design

c. Multi-font and font size capability including:

   1. Individual character width definition;

   2. Automatic leading control, permitting any font/size combinations;

   3. Rapid identification of font/size on the CRT; and

   4. Accommodation of special symbols and foreign languages.

d. Complete automatic repagination capability including page breaking controls, column balancing, header generation by specification and from context, page numbering format control (e.g., 4-21 where chapter number prefaces page number).

e. Comprehensive, simple, edit capabilities which are easier to use than typical word processing systems (because they combine line context edit capabilities with cursor positioning capabilities) yet as powerful as typesetting systems because automatic on-line justification occurs simultaneously with update. These include:

   1. Insert;

   2. Delete;

   3. Change (with repeat if desired);

   4. Search (with repeat if desired);

   5. Position cursor (forward, backward, up, down, by line number, etc.);

   6. Scrolling; and

   7. Hyphenation defeat or override.

f. Multiple column definition

g. Nesting of columnation (columns with columns).

h. Left, right and center justification, applying to the page width, column width, or between any two specified tab positions (e.g., center justify between positions (1/2 pica) 10-50).

i. Diagram insertion and maintenance capability eliminates manual paste up.

j. Tabulation and automatic indent controls.

k. Directory access to multiple versions of books and chapters.

l. Flexible book and chapter format definition, or on-line redefinition.

m. Complete global edit capability permitting string substitution or deletion and simultaneous rejustification at high speed throughout the document

n. Password protection by function.

o. Maintenance of a line index within a page enabling direct access to any part of the page either by cursor positioning, scrolling, or instantly, by specifying a line number.

p. Maintenance of update bars for technical publications.

q. Maintenance of CRT and proof list proofing flags indicating where changes have occurred.

r. Complete logging of all commands and production of a management information report based upon the log.

s. Auxiliary monitor which displays typesetting information allowing manual override of automatic decisions.

t. Proofing mode which logs approval or review status enabling document control.

u. Ability to handle a variety of special symbols, graphics or logos.

v. User definition and automatic system maintenance of and access to any desired index to the entire publication (e.g., access by paragraph number, embedded text, titles, headers, footnotes, etc.).

w. Maintenance of pages as distinct entities enabling document update and instant access by referring to the original page number; regardless of additions, changes, reformatting, or deletions in the interim. Text is not redistributed among pages until repagination is specified. After repagination the original is separately maintained and available as a "version."

x. Storage capacity is available to store from 50,000 to 1,200,000 pages of information depending upon configuration selected.

y. Programmed in a high level language (FORTRAN), allowing rapid additional programming and support to meet specific user requirements now and in the future. System improvements will be available to users without hardware upgrade.

z. Human engineered; training courses available to permit comprehensive operator training.

aa. System controls and complex features when not invoked remain invisible to the operator. The system can perform at the operator's level; in less than one hour a typist with no previous exposure to the system can compose typographic quality correspondence.

bb. Usable in a multi-user environment on a suitable, general purpose (currently operational on a Data General ECLIPSE minicomputer) computer, allowing users to run other applications of their choice simultaneously. Furthermore, both the terminals and the printer are usable for other user applications when not used for publishing or word processing applications.

cc. Automatic column balancing and page makeup.

dd. Vertical tabulation.

ee. On-line HELP function for interactive format and repagination specification assistance.

ff. Columns, page width, tabs, indents, font/size, update bars, and hyphenation controls propagate throughout the entire document but can be easily redefined at any chosen place in the text; providing complete and flexible format control of any document regardless of size or makeup.

gg. User definable function keys and mnemonics permitting the automatic entry of any combination or commands and textual data of any length.

2.3.1.2 Subsystem Data Base

The data base structure of the Publishing Subsystem is designed to accommodate that data necessary for the production of the flight information publications prepared by the Defense Mapping Agency Aerospace Center and to provide for the ready access and maintenance of this data. Care has been exercised to avoid restrictions which would likely cause substantial redesign and conversion when enhancements to the subsystem result in additional maintenance functions and access requirements.

Where repeated occurrence of a data item would be a particular burden on storage, maintenance, or manual editing, data items have been incorporated to allow relief (as in the case of alternate font and tabulation specifiers).

The data base is intended to be supported by a Data General Real Time Disk Operating System, although there are no inherent aspects which would encumber its support on any system which supports a mass storage device with equivalent characteristics to that of a moving head disk.

Four types of files are used to maintain the publications. They are linked together as shown in Figure 2-8. The book file is a contiguous file of maximum length of 16,384 bytes. There is one book file for each publication. It serves as an index to each of the chapter versions (CV's) comprising the publication. The chapter file contains the contextual and formatting data for the publication. The font files contain that data needed to convert the chapter file font designations into EBR designations. The page index file is generated at publication time during repagination if the chapter descriptor contains the appropriate indicator. It is used to address pages of a supplement chapter by facility name. Additionally, there are system utility files and transient files including RDOS command file (CoM-CM); Publishing Subsystem Command File; and System Log.

a. Book File. The book file is a contiguous file of 16,384 bytes consisting of one 64 byte header followed by as many as 255 64-byte CV discriptors in a contiguously organized file.

FILE HEADER

	Description	Bytes	Contents
1.	File type identifier	2	"BK"
2.	File type version	2	0
3.	Number of bytes in header	2	64
4.	Number of bytes per entry	2	64
5.	Title of book	16	ASCII
6.	Number of entries; chapter	1	0 to 255
	versions (CV's) Filler	39	Nulls
		64	

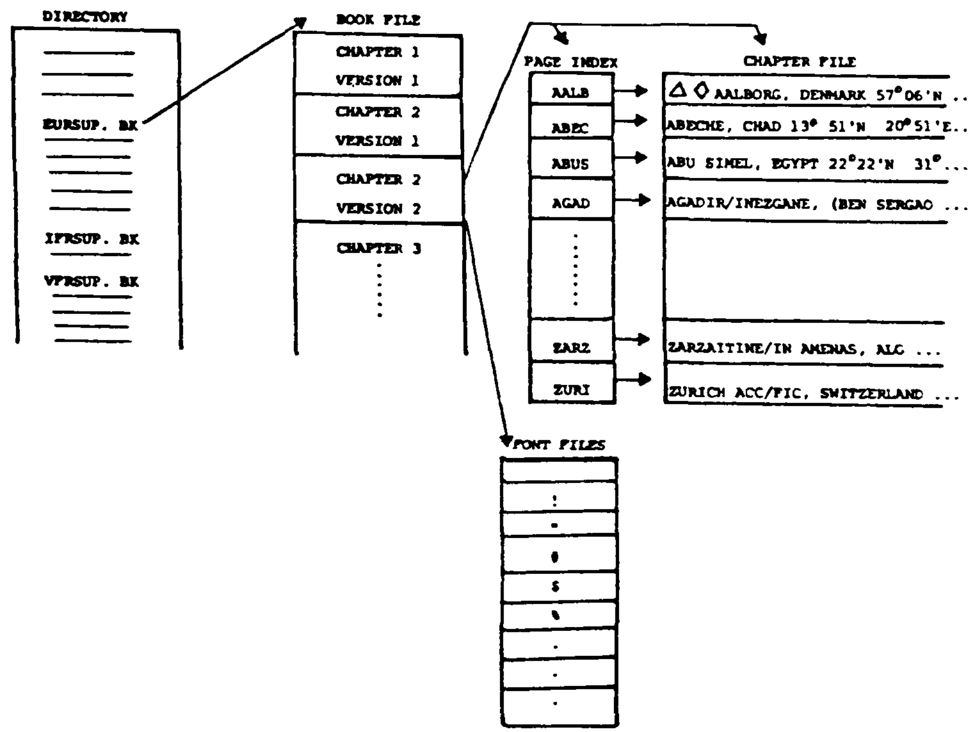

Figure 2-8. File Structure

CV DESCRIPTOR FORMAT

Field No.	Field Description	Bytes	Format	Contents
1	Chapter (CV) Title	16	RADIX 40	1-256
2	Chapter Number	1	Binary	1-256
3	Filler	1	Byte	Null
4	Version Number	2	Binary	1-6561
5	Vertical Page Size	2	Binary	Pica
6	Horizontal Page Size	2	Binary	Pica
7	Chapter File Record Size	2	Binary	Bytes
8	Chapter File Size	2	Binary	Records
9	Date of Last Update	2	Binary	Date
10	Date of Last Publication	2	Binary	0 or Date
11	Size of Font No. 1	1	Binary	Points
12	File Name of Font No. 1 Data	3	ASCII	FONTaaa.F
13	Size of Font No. 2	1	Binary	Points
14	File Name of Font No. 2 Data	3	ASCII	FONTaaa.F
15	Size of Font No. 3	1	Binary	Points
16	File Name of Font No. 3 Data	3	ASCII	FONTaaa.F
17	Size of Font No. 4	1	Binary	Points
18	File Name of Font No. 4 Data	3	ASCII	FONTaaa.F
19	Size of Page Number Font	1	Binary	Points
20	File Name of Page Number Font Data	3	ASCII	FONTaaa.F
21	Page Number of First Page	2	Binary	1-32767
22	Number of Pages	2	Binary	2-1024
23	Vert. Page Number Position (Top, Bottom)	1	ASCII	T, B
24	Horiz. Page Number Position (Inside, Center, Outside)	1	ASCII	I, C, O
25	Accompanying Page Number Data (Title, Nothing, CV Title, CV#)	1	ASCII	T,Blank,C
26	Page Index File Code (None, Will Generate, Yes, Will Stop)	1	ASCII	Blank,G,Y
	Filler	4	Bytes	Nulls
		64		

b. Chapter File Design. Each chapter file is a contiguous MRDOS file containing records of 16,384 bytes (32 sectors) each. The file name for this file is a function of the book title and the chapter and version number as specified in the CV descriptor. Each of these records represents one page of data as it would appear in the publication or as subsequently updated. Repagination occurs only during EBR output tape generation at publication time. Each record contains a 32-byte header containing status information carried over from the previous page followed by 16,352 bytes

of contextual and formatting data (see Figure 2-9). Although 16,352 bytes is triple the amount of room required by a typical page, this much room has been allocated to accommodate extensive modifications during the update process. Although this contiguous structure will result in disk allocations of 6.5 million bytes for some publications (versus 2 million for a more compact format), the fourfold (or more) decrease in record access time makes it well worth this consumption of a rather minor portion of the 192 million bytes of disk storage.

c. Page Record. The body of each record contains 16,352 bytes. Each of these bytes contains an ASCII character in the low order seven bits and an update flag in the high order bit. At publication time the update flags are cleared. As data is subsequently added, it is added with its update flag set. When data are deleted, they are replaced with a byte containing a null with its update flag set (unless the data deleted had all update flags set), one such null for each string deleted.

The update flags are used to indicate what data has been modified since the last publication. With this the solid vertical bars can be automatically placed to the left of the column or page indicating that a change has taken place. Whenever a publication is generated all of these flags can be cleared. Then as data is added, it is added with the flag set and as data is deleted it is replaced with a null with a set flag when any of the deleted data has a cleared flag.

The following table contains a description of all data items which can be included in the ASCII text data string within a chapter. There are, however, two major divisions:

1. Operations-including Opcodes, specifiers, and delimiters; and

2. Nonoperations-including null, control codes, ASCII data, and indicators.

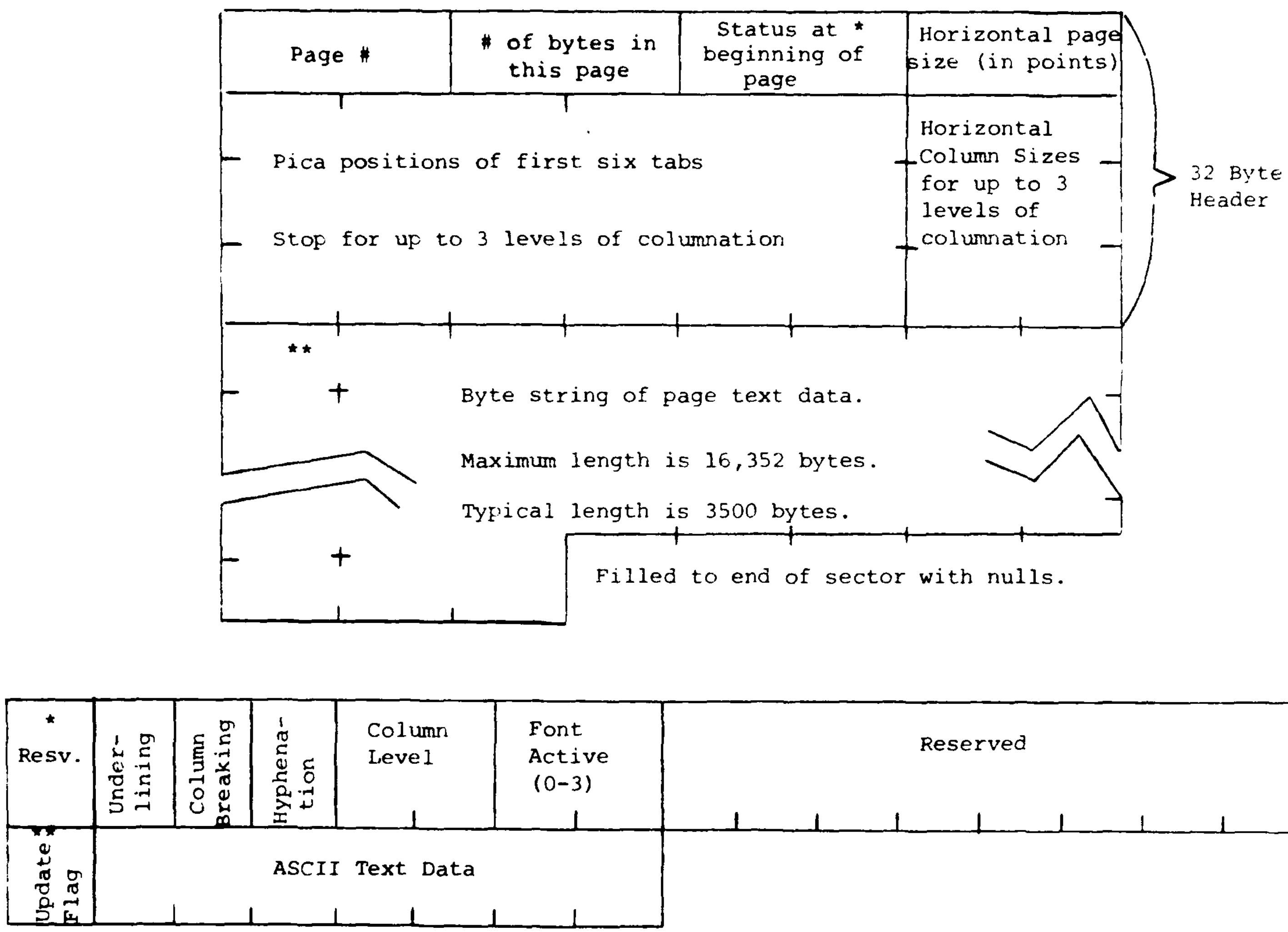

Figure 2-9. Chapter File Format

Octal Code(s) of First Character	Data Item Type	Functions
000	Null or Filler	To take up space or (when the update flag is on) to indicate that items formerly in this position have been deleted since the last publication.
011 to 015 and 021 to 024	Control Code	To control horizontal (011) or vertical (013) tabulation, page/column control (012 and 015) or termination (014), or font/size selection (021 to 024).
074 and 076	Operation	To specify column parameters, horizontal or vertical tab positions, font/size selections, diagram placement, horizontal justification, hyphenation or columnation restriction, titles, or horizontal column spanning lines.
040 to 177 except (074, 076, 133, 135, and 137)	ASCII Data	To specify contextual publication data.
133 and 135	Indicator	To specify enclosed text is to be underlined.
137	Indicator	To specify next byte contains a special or circled character.

(a) Operations are delimited by an initial <(Octal 074) and a terminal> (Octal 076). Between the delimiting character is the one or two character opcode followed in some cases by additional specifiers. The opcodes are:

Opcode	Specifiers	Function	Level
H	No	Horizontal line spanning page or column (also terminates line)	4
CL	Yes	Specifies column parameters for data which follows (also terminates line)	3
TC	No	Terminate columnation	3

Opcode	Specifiers	Function	Level
MS	No	Allow midstream column/page breaks	4
TM	No	Don't allow midstream column/page breaks	4
TB	Yes	Set horizontal tab stops	4
V	Yes	Set vertical tab stops	2
LJ	No	Select left justification (normal)	5
CJ	No	Select center justification (between tab stops)	5
RJ	No	Select right justification (to next tab stops	5
LD	No	Left justify in a field of dots	5
D	Yes	Specify position and identification of a diagram	5
TL	Yes	Specify a column title (implicit column break)	4
HY	No	Allow hyphenation (except across pages)	4
TH	No	Terminate hyphenation allowance	4

The level numbers indicate under what circumstances the operation can be used. Some of the operations (CL, TB, V, D and TL) can include one or more specifiers that have the following structure: a concatenation of data items delimited with a leading "<" and terminating ">". Within such a structure not all data items can be used. Specifically, only those data items with a level number greater than the level number of the item containing the specifier can be used. For example, suppose a diagram is to be specified. Once of the specifiers that can be included in the data item for diagram specification designates the identification or label of the diagram. This specifier can only include data items of levels greater than 5. (5 is the level of diagram specification item). Therefore, operation type data items cannot be used in the diagram specification.

(b) Non-operations are other data items which have the following levels:

Data Item	Level
Null or filler	1
Control codes	5
Operations	2-5 as described above
ASCII data	6

During data entry at an edit session the level of entry starts out at one; therefore, nulls cannot be entered directly.

There are nine control codes:

Control Code	Octal	Function	Level
TAB (↑I)	011	Horizontal tabulation (like CR if no tabs)	5
LF (↑J)	012	Start on next line (next column if need be)	5
VT (↑K)	013	Vertical tabulation (like FF is no vertical tabs)	5
FF (↑L)	014	Start on next page/column	5
CR (↑M)	015	Start on next line (same column unless opcode MS)	5
DC1 (↑Q)	021	Select font/size 1	5
DC2 (↑R)	022	Select font/size 2	5
DC3 (↑S)	023	Select font/size 3	5
DC4 (↑T)	024	Select font/size 4	5

When font/size 3 or font/size 4 is selected, text in this font appearing on the Datagraphix terminal will be bright. At pagination time letters in font/size 4 will be used to build the page index file (if generation of this file is indicated) and text in this font will be displayed just prior to edit time as pages are turned in search of the correct page.

d. Font File Design. The font file is a fixed length contiguous MRDOS file 384 bytes in length. The name of the file is "FONT***.F" where "***" is any alphanumeric characters. The file is made up of 96 four byte entries each representing one of the 96 ASCII characters from Octal 40 to Octal 177. Each entry

has the following format ("*" represents the ASCII character that the entry data describes):

Field No	Field Description	Bytes
1	EBR output value for "*"	1
2	Horizontal increment (in points) for a 9 point "*"	1
3	EBR output value for a circle, dot or triangle "*"	1
4	Horizontal increment (in points) for a 9 point circle, dot, or triangle "*"	1
	TOTAL	4

This file is used at edit, pagination, and EBR output time.

e. Page-index file design. Generation of the page-index file occurs at repagination and EBR output generation time in response to an indicator in the CV descriptor of the book file. The page-index file is a sequential file of four byte ASCII entries, one such entry for each page in the CV file to which the index supports. The file name of the page-index file is identical to the file name of the corresponding CV file except for the extension which is ".CV" for the CV file and ".PI" for the page-index file.

Each four byte ASCII entry is developed from the first occurence of a string of characters in font/size 4 in the page of the chapter corresponding to that entry. This file is then used at page select time (during an EDIT session) to generate a page number from a facility or paragraph name.

f. The Log File. The log is a sequential file of strictly ASCII data. Each entry contains the following data:

	# Char	Example
Year	2	77
Month	3	JUN
Day	2	30
Space	1	
Hour	2	18
Colon	1	:

	# Char	Example
Minute	2	16
Space	1	
Command	2	DC
Space	1	
Other Data Such as the Book Title		
Carriage Return	1	
Sometimes followed by Other Lines Which Begin with a Space and End with Carriage Returns		

The Other Lines May Include Error Messages:

Space	1	
Error Code	3	100
Space	1	
Error Message Possibly Containing Parametric Data Detailing the Error Condition		
Carriage return	1	

For the background the name of this file is $PUBBLOG.TB. For the foreground, $PUBFLOG.TB. These files are maintained in chronologically ascending order.

g. Command file COM.CM. The action taken by the Command Line Interpreter (CLI) upon reading a command line is sufficiently flexible so that users can, if they wish, design programs to perform system command functions.

When either the background or foreground CLI reads a command line and does not recognize the first file name, the CLI always builds a command file (preceding the loading of the save file of that name). The command file reflects an edited version of the command line. The name of the command file is COM.CM if it is built by

the background CLI. The foreground CLI builds a command file identical in structure to COM.CM, but the foreground command file is named FCOM.CM.

h. Command File $PUBBCOM.TB. The command file generated by CLI (COM.CM) is parsed before being processed by PUB. This parsed data is approximately the same ASCII data as was entered except that the "PUB," and the command code have been removed and the file is terminated by two consecutive carriage returns. The file is sequential and is named $PUB.COM.TB or $PUBFCOM.TB for background or foreground respectively.

2.3.1.3 Software Functions

The software components of the Publishing Subsystem are depicted in Figure 2-10. The major functional areas are as follows.

a. Log-on/log-off

b. Publication identification and creation

c. Display manipulation

d. Update pages

e. File management

f. Publication reports and statistics

g. Repagination and output to EBR

h. Publication proofing

1. Log-on/Log off. This process permits access to the system only after the entering of a password. A hierarchy of password validity insures that only authorized personnel can utilize specific system functionality. For example, the password QRSTWVW may grant access to publications for revision and update but not for repagination, delete book, etc.

2. Publishing Identification and Creation. The functions to be performed under this category are:

   (a) Print book or chapter;

   (b) Identify or select book or chapter; and

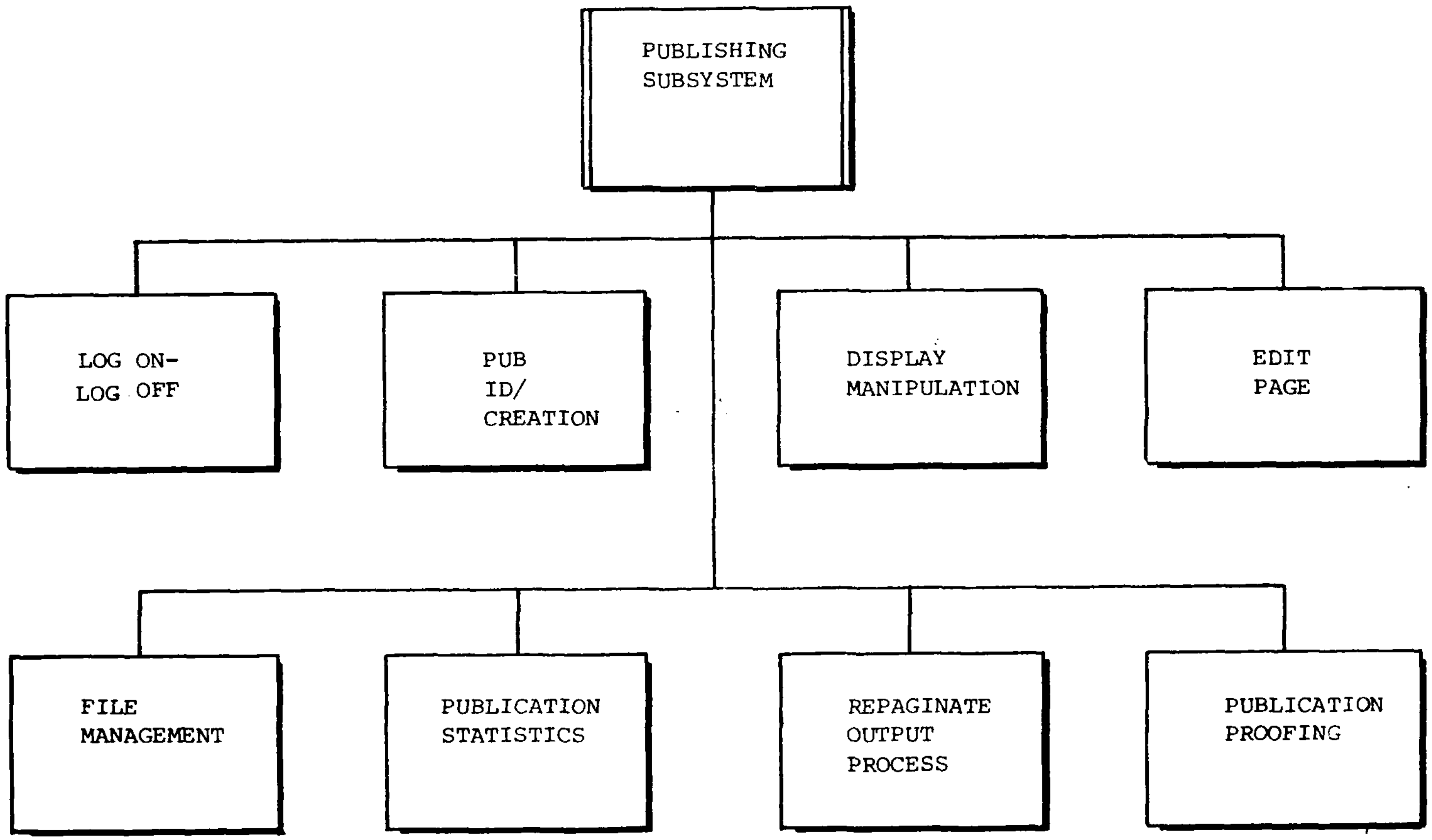

Figure 2-10. Publishing Subsystem Software Components

(c) Update book or chapter.

A book file serves as an index to all chapters and chapter-versions (current and past publications having the same title and format). A chapter file contains format definition and heading information as well as the text and operation codes that form the substance of the publication. Chapters are divided into page divisions until the cut-off point in a publication cycle results in repagination and output. This is because the best reference an analyst has to a change is the page on which it appeared in the last published version. If page divisions were not maintained during the update cycle it would be difficult to reach desired places within the publication as text migrated from page to page reflecting update activity.

The publishing subsystem maintains indices to pages within chapters. This practice permits the system to automatically generate chapter page headers, ensure chapter integrity during repagination, and provide faster response times than associated with a simple book/page index.

3. Display Manipulation. At the core of the Publishing Subsystem is the ability to revise the contents of an existing chapter. To actually perform this function, however, an interface to the system must exist which permits the rapid display of that body of text which must be updated. It is this vital function of getting to a page, moving the display cursor within the page, and scrolling the display which is functionally incorporated into 'Display Manipulation'.

There are two methods of reaching a page before updating a chapter. If a page number is specified, the system will retrieve the corresponding page of data and display the first 12 lines of the page. One may scroll forward to view the remainder of the page.

Indexed documents permit use of the "+" and "-" keys to go from page to page displaying facility names as a guide to page content. The "+" pages forward and "-" pages backward.

Cursor-control positions the cursor for add and delete functions, as well as causing the screen to scroll when the cursor is ordered off the screen.

The display commands offer a more rapid means of controlling which part of the page is to be shown on the screen. Using the display function also provides the advantage of maintaining the cursor in the same position on the screen.

4. Update Page. The Update page function provides absolute control of the content and format of the document. This function is composed of the following subsections:

   (a) Manipulate format;

   (b) Search for string; and

   (c) Change/insert/delete string.

The subsystem has the ability to store and manipulate format operands such as tabulation, columnation, justification, hyphenation control, font/size selection, and diagram insertion. Essentially, the operand supplied by the operator causes a command to be stored in the body of the text which results in correct formatting both on the screen and during pagination.

The Update function permits the search for a given string or combination of characters. It is used both as a cursor positioning function and as a vital subfunction in the changing of character groups.

Update performs the function of actually inserting characters and operands into the page of text. Positioning the cursor to a character and invoking the delete function causes the character to be removed from the page of text. The change command is used to replace a given character group or string with another of the same or different size. Automatic justification will expand or contract the line accordingly after this command is invoked.

Additionally this command can be invoked to change any number of consecutive occurrences of a string on a page to another string of the same or different size.

5. File Management. Utilities having to do with file management include:

   (a) Update log file;

   (b) Update font file;

   (c) Store package files; and

   (d) Create book or chapter.

   A log of all system functions is kept including;

   (a) Function performed;

   (b) Time of day performed;

   (c) Date; and

   (d) Password identification.

   From this log management statistics may be generated. Additionally a proof management report reflecting the status of a publication through proofing is available to insure adequate proof management.

   The font file forms the link between the representation of characters within the publishing subsystem and their depiction upon the EBR output device. Essentially, the contents of this file are the codes by which the EBR will recognize the character to be produced on the film prior to blow-up to left size.

6. Publication Statistics. Publication statistics are collected and may be displayed.

   Since all changed characters are flagged it is possible to derive a number representing the number of characters entered to the publication (though not the number deleted). Net change can be calculated by comparing the character counts for successive publications. These statistics are normally retrieved and printed for management use.

7. Repaginate and output process. The repaginate and output process is the most complex function of the Publishing Subsystem. All the embedded operands controlling format are translated into a completed product. The constituents of the

repaginate function are:

(a) Identify the publication;

(b) Perform global edits;

(c) Paginate the publication;

(d) Create new indices; and

(e) Output the EBR tape.

The function requires bringing in all relevant book and chapter descriptors and parameters that define page headings, leading requirements, etc. In addition this function brings in a global edit file which permits the changing of one character string for another throughout the entire chapter. This capability would facilitate the incorporation of new abbreviations on the changing of symbology automatically.

During global revision pages are brought in and merged into a depaginated output stream. This stream is then checked, a group of characters at a time, to accomplish the substitution of one set of characters for another that constitute the global revision function.

The depaginated globally revised stream is transformed into a new chapter version with new page numbers. Other subfunctions include:

(a) Vertical and horizontal leading;

(b) Look ahead ability to space out a page; and

(c) Determination of best fit.

Many of the functions contained here are used during update on a single page at a time to depict the page in as close a manner as possible to the way the repaginate function will actually treat the data.

Page indexing requires the building of a page index for selected publications corresponding to the first four letters of a facility name. This enables rapid entry into the chapter when the page number is not shown. Any text on the page may be used as an index to the chapter.

The final stage is the translation process whereby the revised and paginated chapter is converted to a format usable on the EBR output device. Once the translation has occurred the formatted publication becomes available to the Charting Subsystem as a magnetic tape for merging the necessary graphics with the formatted pages produced on the Publishing Subsystem.

8. Publication Proofing. The Publishing Subsystem is designed to permit a high degree of versatility while satisfying the other design objectives of cost-effectiveness, speed, high quality control, and ease of use. Versatility permits AD to structure their data flow and related personnel procedures in a manner which AD management feels best fits their needs. Synectics has not presumed to forecast such policy decisions, but has provided the capability to operate the update and proof functions, and to maintain an on-line status log for each activity. Such a capability would permit, for example, person A to "edit" changes from a given batch of green slips while person B would "proof" the changes generated by that batch. The system would maintain a management log of what work was revised, what was proofed, and what remains to be proofed.

An important facet of quality control is the ability to maintain accurate compostion control parameters (e.g., font and type size parameters). Thus, composition control parameters are not displayed unless requested and are not, therefore, normally available for revision. During proofing they can be requested for display on the CRT or line printer.

Although the Publishing Subsystem is an interactive system and all updating, proofing, and revision functions can easily be performed through the system terminal, provisions have been made for generating hardcopy listings, chapters or books including composition.

During proof sessions no updates or revisions to the document can be effected. To accomplish an update the reviewer must, at minimum, exit proof mode and log-on in update mode. The operation sees the first 12 lines of text on the page just as in update mode. Format is verified on the terminal moving the cursor to the next change in composition control parameters and observing the small display of the font, type size, and lead for the text that follows. Showing the proofer exactly what font and type size is being specified rather than trying to simulate the font and size on the CRT should help maintain a higher degree of quality control. Exact presentation of font and type size parameters does not leave any decision to chance interpretation of what is meant to be presented.

The design of the proofing function placed considerable emphasis on human factors and quality control.

(a) All currently used symbols are available through the terminal.

(b) Composition control parameters are protected.

(c) "Update/Proof" management log protects system integrity.

(d) Items are retrieved by page or name.

(e) Chapter page headers are generated automatically.

(f) Publication parameters and user commands are segregated from publication text.

(g) The last command is displayed in addition to current or next command.

2.3.2 Air Facilities

The Air Facilities Subsystem is tasked with the responsibility of maintaining the AAFIF data base and supporting on-line queries, selective data base retrieval, AAFIF special report generation, scheduled tape and hardcopy report generation, and generation of formatted tape files for the Charting output device to record film positives of the ASSOTW report. (Reference Figure 2-11.)

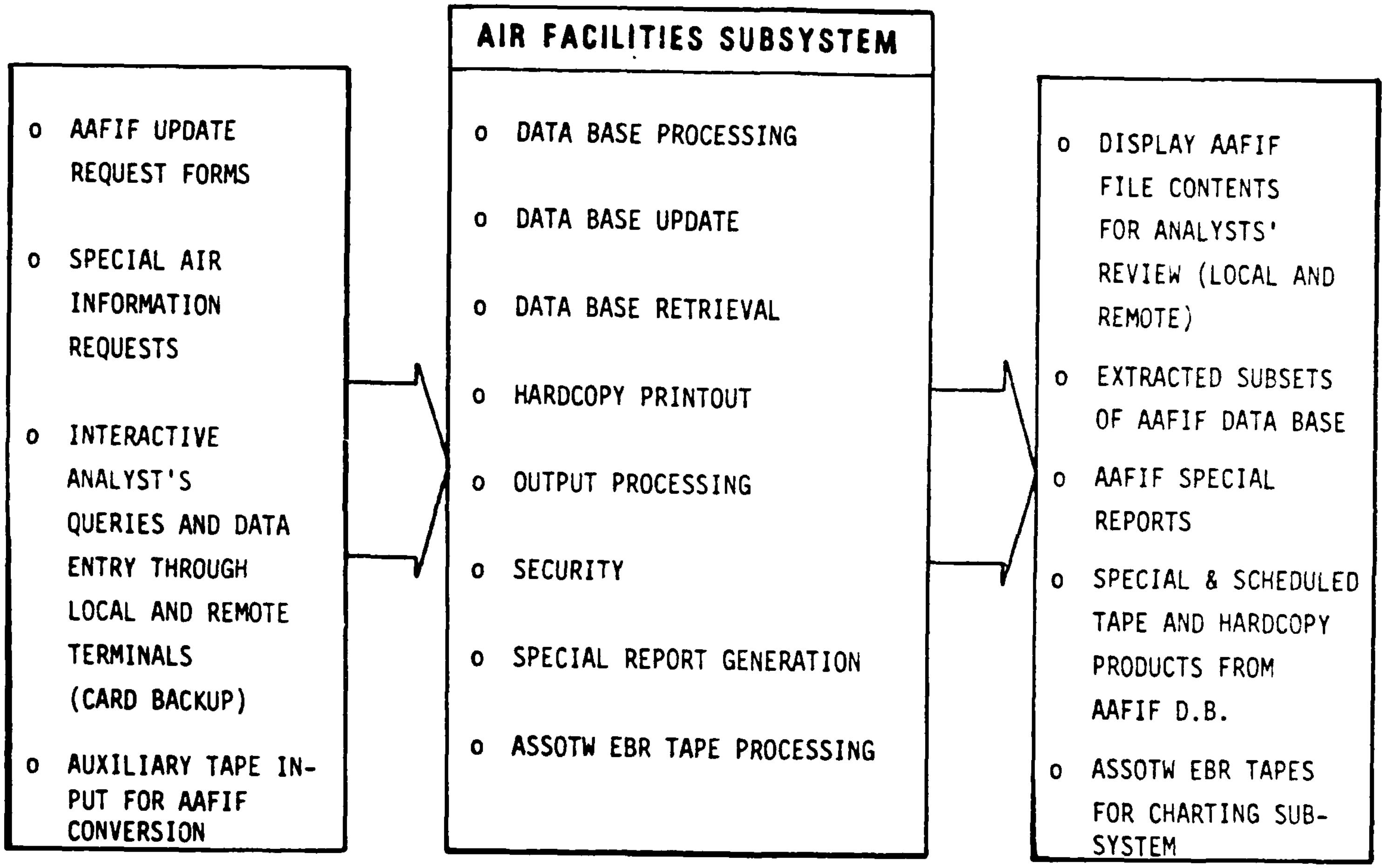

Figure 2-11. Air Facilities Subsystem Functions

The subsystem is required to receive input in the form of AAFIF update request forms, special air information requests, interactive analyst's queries and data entry through local and remote terminals, and auxiliary tape input for AAFIF conversion. The provision of data base processing, update and retrieval, hardcopy printout, output and ASSOTW EBR tape processing, security, and special report generation are additional requirements of the subsystem. Compliance with these requirements results in the following outputs: extracted subsets of AAFIF data base, AAFIF special reports, special and scheduled tape and hardcopy products from AAFIF data base, and ASSOTW EBR tapes for the Charting Subsystem. The Air Facilities Subsystem also provides the means for displaying AAFIF file contents for analyst's review (local and remote).

The Air Facilities Subsystem data base is designed to assist in the maintenance and production of ASSOTWs, SAIRs, and update functions by the Defense Mapping Agency Aerospace Center. The effort's main purpose was to create an on-line retrieval and update system that permitted interactive dialogues between users and the computer. This subsystem contains the 45,000 airfield records of the AAFIF data base and completes an average of 2,000 update transactions per day. The major functional areas of the Air Facilities Subsystem are: data base initialization, data base update, data base retrieval, product output. These areas allow the subsystem to fulfill its requirements to AAIPS as well as utilizing the Automated Air Facilities Information File (AAFIF).

2.3.2.1 Capabilities

The following capabilities are provided by the Air Facilities Subsystem:

a. On-Line Capability. This provides a capability to perform AAFIF data base maintenance by permitting the operator to add, change, or delete individual data elements or whole records with ease and timeliness.

1. Log-on/Log-off

(a) Include an access authorization capability through a combined password processing and geographic identifier validation scheme. Correlate password and geographic identifier for proper match.

(b) Ensure that the operators cannot access the command language of the operating system (CLI) or the facilities of the AAFIF system programs.

(c) Provide a log-off function with reactivation of all access controls.

2. Display Processing

(a) Generate display files or menus for on-line communications that lead the operator as well as the on-line software to proper display, decision, and processing sections.

(b) Make the display processing functions safe (avoidance of system crashes) as well as clear and self-explanatory (teaching-machine characteristics).

(c) Create display files and display file structures with application area designations, retrieval indexes, display text, header, and communication (error) messages and subroutine call arguments.

3. Input Processing

(a) Program a special on-line data input module with automatic cursor positioning and 'tick mark' generation to indicate (and limit) the input field on the screen.

(b) Include simple-to-use input conversion capabilities such as character delete, line delete, input escape, and possible exit to a previous program level.

4. Retrieval

(a) Establish a simple record identification procedure with retrieval modes: single element, groups of elements, page/continuation page, and the retrieval of multiple data elements (e.g., multiple runways per airfield).

5. Update

(a) Allow for a single element, group of elements, page/continuation page, and

'multiple' on-line update capability. Hold all updates for final validation (logic checks).

(b) Perform automatic format checks for each data element entered. Give immediate input error indication with options to repeat or skip the faulty data element input.

(c) Create a temporary file containing all update information. Ensure that file is saved in case of system failures (e.g., power outages), or can be requested to be saved (in case of update-rejections due to logical checks) for later continuation or update correction.

(d) Perform logical checks that correlate selected data base elements to make sure that entries fall within reasonable ranges and that correct information categories have been chosen (i.e., make sense). Prevent updates that do not pass logical checks from being entered into the data base.

(e) Provide for an automatic update function (computed input) that is triggered by the update of other data base elements, correlated by logical tables (usually for a changed data category that represents a group of related elements).

(f) Implement on-line text edit and update capabilities with string search, string replacement, and update verification schemes.

6. Add

(a) Program a capability for the on-line addition of an entire airfield to the data base. Assure a guided, page-wise, and item-by-item information entry that avoids skipped data fields and human oversights.

(b) Make the elaborate UPDATE functions available to the ADD process by generally treating the ADD process--including format tests, logical checks,

and computed inputs-as an UPDATE of a (previously 'empty') record.

7. Delete

   (a) Provide a special password/DELETE function correlation through a system access table in order to ensure that the somewhat dangerous deletion of an entire airfield from the data base can be accomplished only by specific, designated personnel.

   (b) Generate log and special output for deleted airfields.

8. Transaction Log

   (a) Maintain a periodic access file containing terminal and airfield information, geographic identifier, date, and time-of-day.

   (b) Keep log of all transactions (UPDATES, ADDS, DELETIONS) as they effectively alter the data base after passing format and logical checks.

9. Save and Restart Capability

   (a) Provide capability for using the temporary file that contains all update information as a SAVE file to continue the update process after a system outage or operator interruption.

   (b) Transfer each data base transaction to disk for safer storage than a file in main memory.

   (c) Implement a deliberate save-file capability to be used by the operator to preserve an incomplete update session (transfer of the 'temporary file' to another that will be kept for later recall).

10. Data Dictionary

(a) Provides a means to define and manage air facility information by identification of AAFIF elements on a schema/subschema level.

(b) Provide for evolving AAFIF data content by being capable of displaying and editing the schema/subschema definitions.

11. Boolean Retrieval

(a) Provide a Boolean search capability for retrieving specific airfield records from AAFIF based on prescribed information contents by determining the selection criteria interactively.

(b) Provide capability to limit the area of search by specifying geographic boundaries and/or WAC cell ranges.

12. Applications Programs

The applications programs deal with a larger section of the data base and are intended to produce reports and magnetic tape outputs to be used by other departments of DMAAC and other agencies.

(a) Provide sort capabilities that allow complex sort key specifications and processing. Implement multi-pass sorting.

(b) Provide a report generation capability for both hardcopy and magnetic tape output.

(c) Provide an interface for FORTRAN programs to support blocked data base records with INFOS structure independence.

(d) Provide a COBOL interface to allow applications programs to access the data base and acquire an entire subcategory of data elements at one time.

(e) Provide a capability to add airfield records entered through a card reader.

(f) Provide an ASSOTW program which outputs an EBR tape for subsequent film positive recording.

(g) Provide an AFFINDEX program which produces an index report.

(h) Provide an AFFUPDT program to generate the DIR transaction tape.

(i) Provide a HISTDUP program to output the AAFIF history file on tape.

(j) Provide software to permit loading of the U1108 AAFIF file from tape.

(k) Provide a means to reconfigure the AAFIF data base when it becomes necessary to add, change, or delete element schema/sub-schema.

(l) Provide a means to reconfigure the AAFIF data base when new countries are created or when analyst assignments change.

13. <u>AFFIF System Programs</u>

(a) Design System Tables for display control, data base element identification, and edit table selection.

(b) Provide capability for establishing password tables and their easy modification.

(c) Develop edit tables for format tests, logical correlations of data base elements, computed (automatic) inputs, Boolean retrievals, password, and Geo-Id correlations.

(d) Provide input programs with table headers and automatic tab settings for the on-line creation of system and edit tables.

(e) Create test programs for the on-line testing and changing of edit tables.

(f) Implement a display session file with hardcopy output for edit table documentation.

(g) Provide a card input program for the 'wholesale' loading of generated edit tables.

(h) Devise programs for formal table checks, load module generation, and systems loading.

2.3.2.2 Design Criteria

a. Air Facilities Subsystem Design. The major emphasis of Phase II was placed on providing a complete system hardware configuration to support remote terminals for multi-user access to the full on-line AAFIF data base. A Data General M-600 computer system with sufficient on-line disk capacity, communications multiplexing components, and a sophisticated real-time multiprogramming operating system was acquired and installed.

The Phase II Air Facilities Subsystem hardware configuration deviated only slightly from the original AAIPS Design Report. The design called for fourteen remote user terminals and two terminals local to the processor. Due to the relocation of the ADA programmers and operators to the AAIPS facility in Building 3 it was agreed that there would be ten (10) remote terminals in Building 4 to support the AIS users in that building. Four (4) terminals would be placed in a secured vault adjacent to the AAIPS facility for use by the AIS users in Building 3. The remote terminals in Building 4 would operate at 4800 bps via Government supplied encrypt/decrypt devices which would interface to the communications multiplexers supplied by Synectics. Synectics also supplied short haul modems (line drives) which perform digital/analog conversion of line signals and interface to the encrypt/decrypt equipment.

b. AAFIF Data Base Redesign. A data base structure redesign to permit the full AAFIF file to reside on-line and to facilitate rapid retrieval for both interactive and applications program processing was performed during Phase II. In order to accommodate the scheduled tape and report production and the

nonscheduled special air information requests
auxiliary file structures were developed.

The PILOT INFOS structure was designed with each data element having its own multi-level key. This was very flexible, but very costly in terms of INFOS overhead.

AAIPS-II Considerations:

a. retrieval time (for airfield);

b. efficient utilization of disk space;

c. simple INFOS structure;

d. ability to support evolving AAFIF data requirements;

e. programming language independence;

f. maximize PILOT software legacy; and

g. support a variety of access types.

The following were the PHASE-II AAFIF Data Base Design goals:

a. minimize the INFOS index levels;

b. effective utilization of index space;

c. data storage efficiency;

d. retrieval types;

e. blocking factor effects;

f. data dictionary "Concept" AOS application interface;

g. effective use of M-600;

h. hierarchically organized airfield data; and

i. multi-language support.

The following items were incorporated in the PHASE-II design to overcome limitations of PILOT AAFIF data handling:

a. additional WAC coordinate limit calculations;

b. generation of UTM coordinates;

c. ability to change airfield elements during add or update;

d. deletion and entry rejection of control characters in text element fields;

e. removal of printed copy option from CRT; and

f. enhanced logic checking capabilities during add or update.

2.3.2.3 Subsystem Data Base

The AAFIF data base contains approximately 45,000 records of air facilities information. It is anticipated that, during production, there will be about 2,000 updates per day. The data base structure has been designed to accommodate all the information necessary for their update and maintenance.

A major effort of the project was the reformatting of the AAFIF, resulting in a new data base definition (Label Book). A major feature was the establishment of a unique, 4-character, retrieval code for each data element of an airfield record, and the accompanying descriptive element name (label).

The retrieval code is used as an 'address' to access a specific airfield data element. However, both retrieval codes and descriptive element names are only stored once in the system to eliminate redundant information from storage. As a consequence, the actual data base contains only the 'essential' information for the specific element of an airfield. For the ease of human interpretation, retrieval codes; descriptive labels; and the actual element information are always combined on the screen. At present an airfield record contains over 640 data elements organized in 'pages' that correspond to 87 subcategories. The data base elements can contain regular alpha or numeric fields, narrative text, or multiple entries (e.g., to accomodate the information for several runways of an airfield).

The element retrieval codes and descriptive labels are stored in special tables (Label Tables). In addition, important control information is included in those tables for program selection; display control; edit; multiple; and text processing instructions. In this way a data-driven capability of function selection has been achieved that allows specific and detailed control down to the element level of the data base.

For the Phase II system both tables and data base elements have been stored on disk using the Data General INFOS data base management package.

a. AAFIF INFOS Structure. Figures 2-12 and 2-13 present the PHASE-II AAFIF INFOS structure. It is a multi-level DBAM file with 3 levels of keys. A key for a subcategory is comprised of:

   1. LEVEL 0 -- SELECTOR MODE;

   2. LEVEL 1 -- WAC/INSTALLATION/COUNTRY-CODE/PROVINCE; and

   3. LEVEL 2 -- CATEGORY/SUBCATEGORY/OCCURRENCE.

   Using this key structure, an entire subcategory can be read within three or four (3-4) disk accesses.

b. Variable Blocked Data Base Records. The approach taken during PHASE-II was to combine data elements into subcategory groups and to handle multiples as occurrences of subcategory groups. Since each subcategory is a different length, variable length data base records are supported. Figure 2-14 shows a layout of this design.

   AAFIF data base records consist of 2 parts: A Record Map , and a Data Part. The Record Map contains this information:

   1. position in record where data starts;

   2. position in record where data ends;

   3. a 3-word field for each record entry; and

   4. the 3-word field contains the status, starting position, and length of each data element in the record.

c. AAFIF Minifile. The AAFIF minifile consists of a subset of significant air facilities elements extracted from each AAFIF airfield record. The file permits rapid retrieval for use by SAIR/DAIR processing.

d. AAFIF Card Image File. This file is equivalent in format to the current card coded U1108 AAFIF file. It is used to facilitate the output of the history file tapes.

2.3.2.4 Subsystem Software

The software organization and control process of the subsystem software is shown in Figure 2-15.

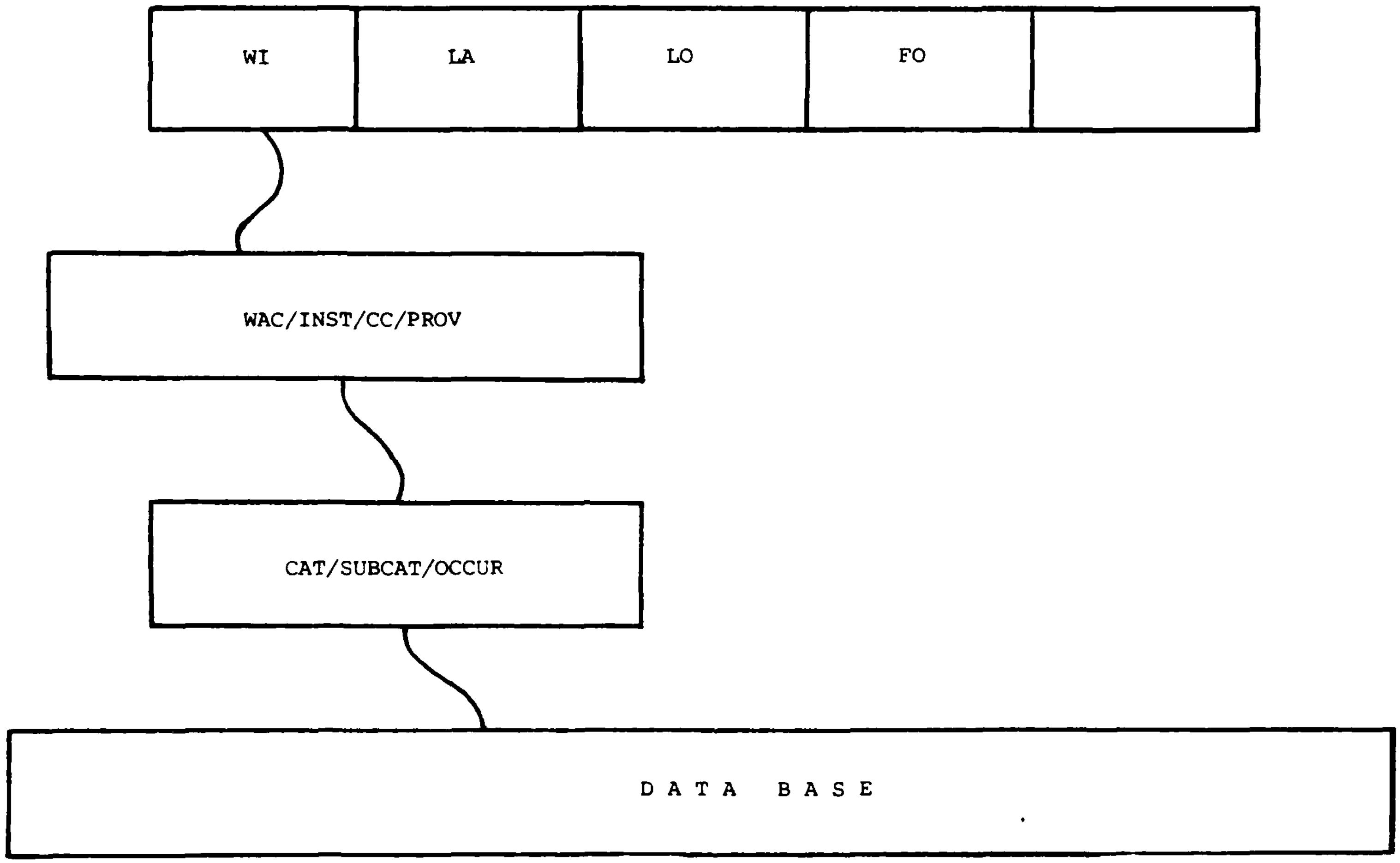

Figure 2-12. INFOS Structure

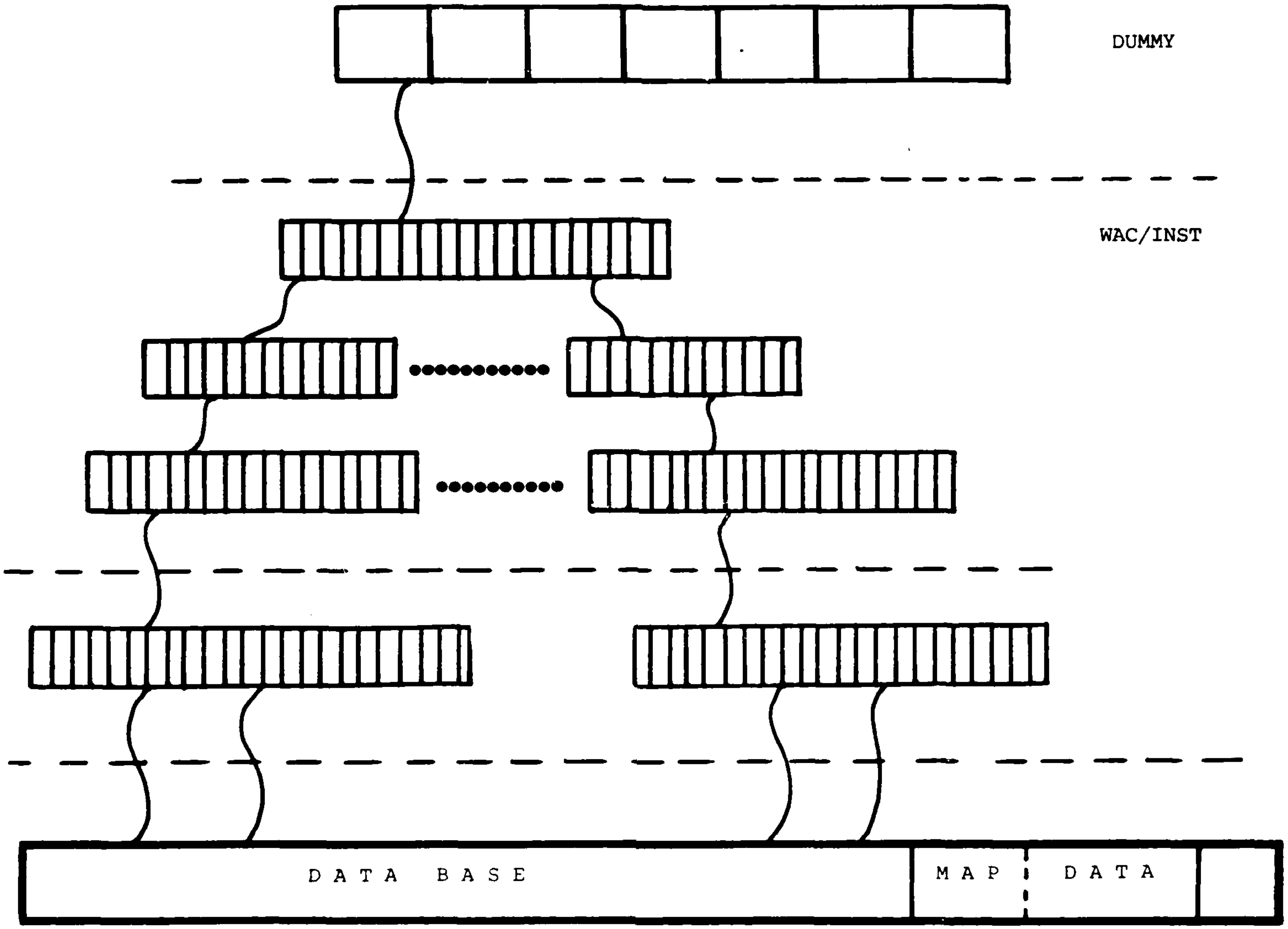

Figure 2-13. Branching Factor and Nodes

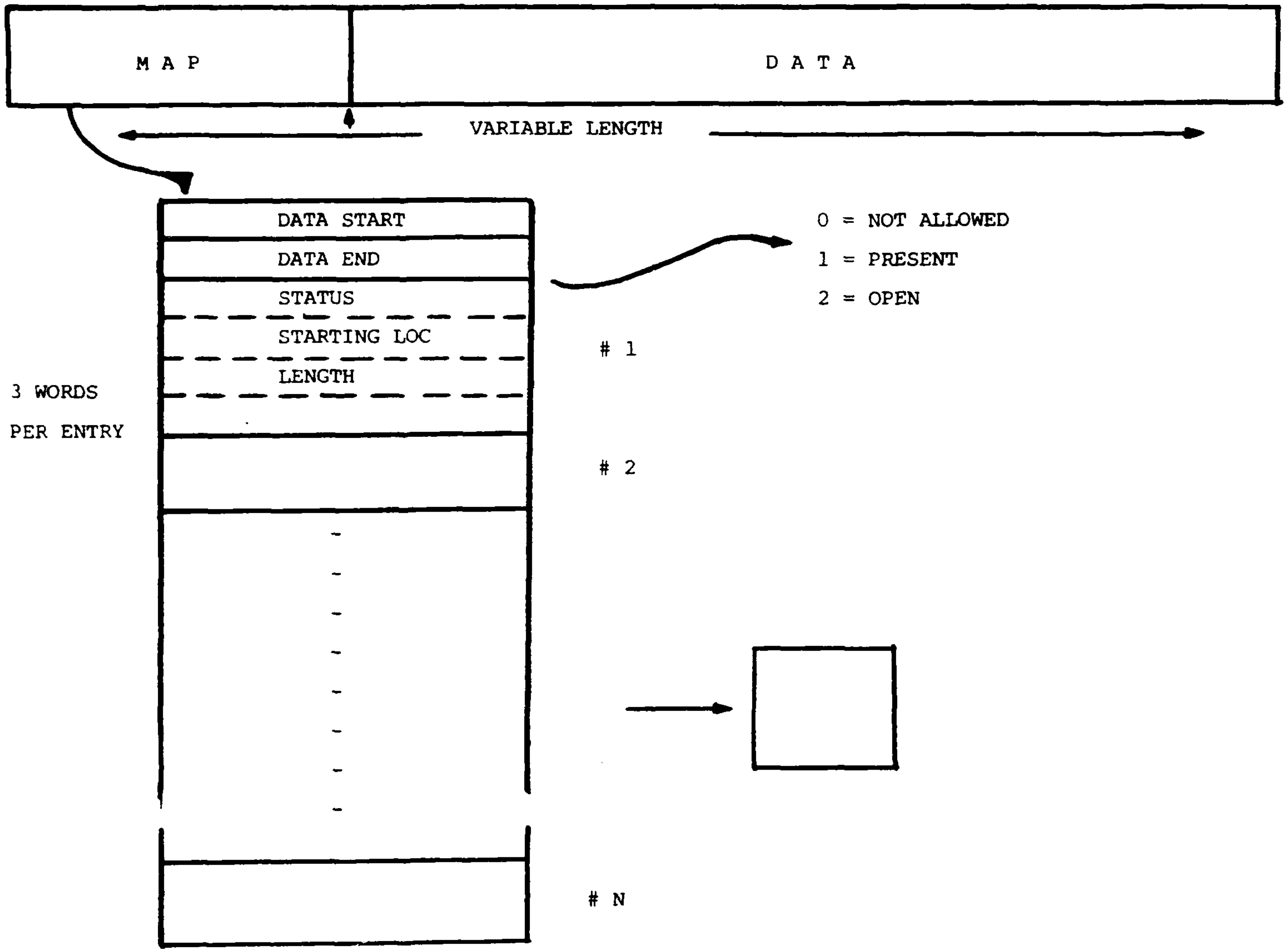

Figure 2-14. Data Base Records

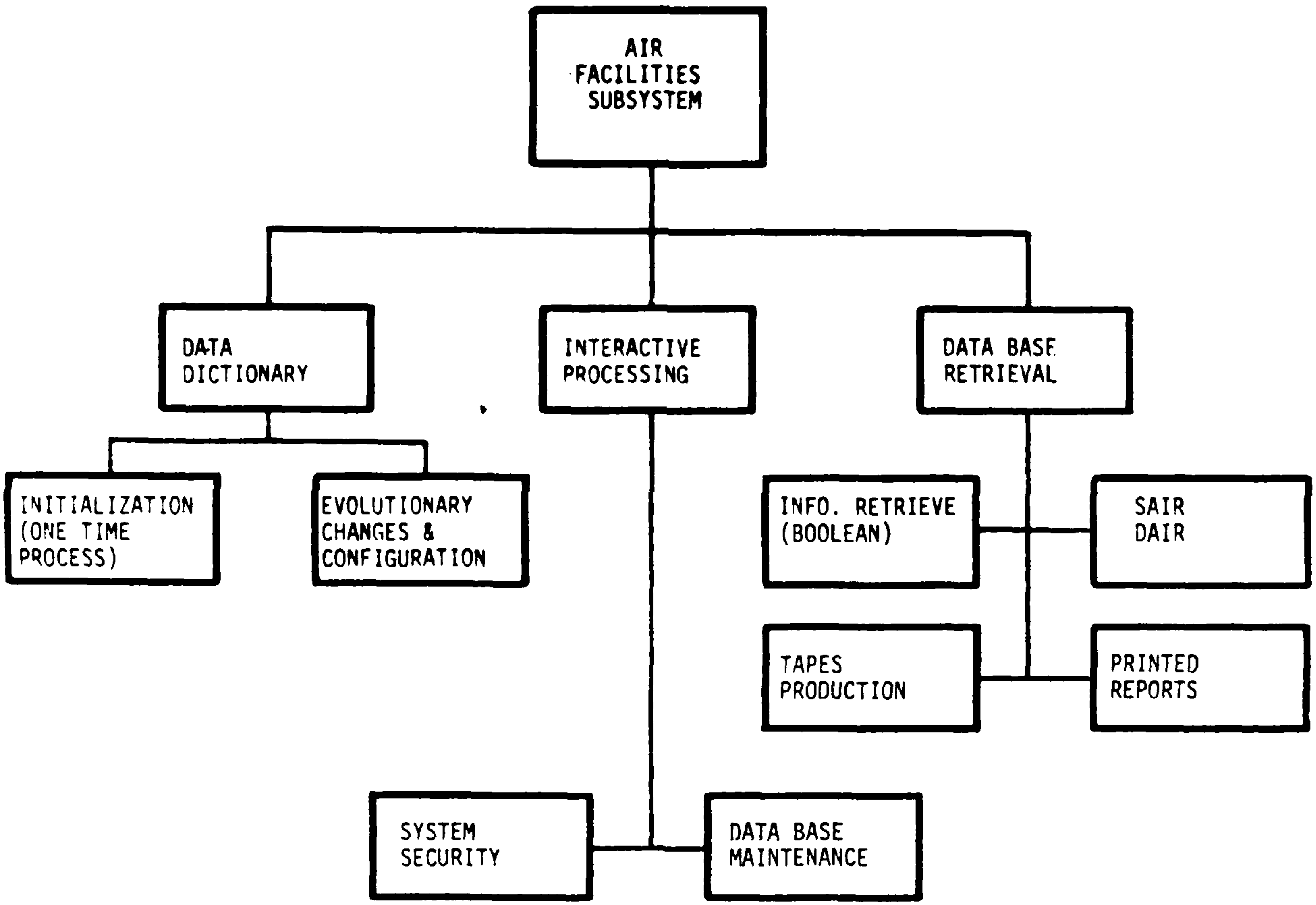

Figure 2-15. Software Organization and Control Process

2.3.2.4.1 Interactive Processing. The on-line Retrieval and Update capability of the Air Facilities Subsystem employs several software modules and series of tables with software characteristics that perform complex functions in a very straight-forward and simple to use manner. The implementation of important software functions and their associated data in table form enables the user to maintain, expand, and (if necessary) restructure the system through data entries. By avoiding software changes and reprogramming efforts in areas most vital to the user, a high degree of vendor independence and system flexibility has been achieved. This adaptability to changed situations will make the system more responsive to the changing needs of DMAAC and is almost certain to save considerable amounts of cost and time in the future.

a. Displays. Two basic types of displays are used to attain smooth interfaces between the user and the computer:

1. menu-oriented displays that permit the user to select from a variety of possible options; and

2. retrieval displays for updating data elements of any record in the system.

The menu-oriented displays provide the interfaces for the various processing functions such as log-on, password processing, updates, Boolean searches, and so on. They allow a menu-oriented dialog that guides both the user and system to any one of the required display data input, processing, and error checking routines. They perform this task in a systematic and safe manner that avoids operator confusion and system crashes.

The retrieval displays present small sections of the data base information for on-line review and update procedures. The display is graphically divided into three areas.

1. The Display Header with essential record information (WAC, Inst. No., Country Code/Province), geographical identifier, date, and time. The Display Header stays the same during the update transactions of an air field (which might encompass several display 'pages').

2. The main display portion depicting a section or 'page' of the current data base information with identifying labels, and a data entry field for new inputs or updates.

3. A communications area for the display of error messages and the input of program control decisions. Whenever an input error is encountered while updating the main section (2), this communications area will be displayed with appropriately selected error messages and response options.

b. Tables. Four types of tables are involved in the processing of the retrieval displays.

1. Label Tables, containing data base element identification codes, element descriptions (labels), display processing instructions, references and program control information for required format and logical checks.

2. Format Check Tables, that specify in detail which specific input data or type of input data, is acceptable as 'new' or 'update' information. The appropriate format check table will be evaluated immediately after each input has been completed. In case of a format failure, the cursor will jump into the communications area (3), with appropriate messages and response options displayed for remedial actions.

3. Logical Check Tables. The format-correct update information for an air field will be held in a temporary SAVE file until all inputs for that air field have been completed. They are then made subject to logical checks that test for valid interrelations between various data base elements.

There are many instances where a format-correct input still could be 'false'--or make no sense--if correlated with other information for that air field. This correlation is performed by the Logical Check Tables. Their extensive use can make the system quite 'intelligent' by constantly applying supervisory functions to the actions of a less knowledgeable -- or less alert -- group of users. In cases where, due to complexity, certain inputs should be made by the computer itself (rather than by the human operator), the

SET command of the Logical Tables implements these inputs correctly and automatically.

4. Communication Tables of the menu-oriented display type. In case of an input error or the completion of a page update, the appropriate communication display with messages and response processing options will be presented to the user for a decision on how to proceed.

An important effort of the project was the reformatting of the AAFIF into an acceptable data base structure. This effort resulted in a document titled "System Design Plan and Specification for AAIPS; Appendix C, AAFIF Data Base Definition" ('Label Book'). Its major feature was the establishment of a unique, four-character, retrieval code for each data element of an airfield record, and the accompanying descriptive element name (label).

The Label Book contains the identifying labels for each of the over 600 data elements of an airfield record. The subsequently generated tables contain this information on a page-by-page basis. Those pages are stored only once in the system to be used for all records (airfields). However, a page will always be displayed on the Datagraphix terminal along with the corresponding information of a particular airfield retrieved from the data base. With this approach a specific label table has to be brought into the main memory for every display page to be processed. The table information is then combined on the screen with pertinent airfield data for the ease of human review and processing.

Synectics' table-driven solution to the editing problem does not require program developments or program alterations to accommodate changing requirements. It permits the ready system loading, testing, and documentation of changed or new edit tables in an interactive environment with immediate computer feedback for testing, verifying, and fully concentrating on the desired editing function.

This capability has been achieved by implementing an on-line test and evaluation package that serves as a comprehensive tool for edit table design and their automatic loading to the system. This package allows the functional verification of all edit tables as they are entered into the system. It displays the actual processing and response to various classes of inputs by showing in detail whether, where, and why a table lets correct inputs pass while incorrect ones are rejected.

The interactive software of the Air Facility system performs the function of permitting the user to access system on-line capabilities.

Basically it consists of a sequence of displays printed at the Datagraphics 132B terminal. These displays request information from the user regarding system function selection, parameter insertion, data entry, as well as present error message display and further selection processing. Responses by the user are entered by depressing the appropriate key(s) at the keyboard.

To perform these capabilities the following software modules have been implemented:

a. a display generator;

b. a Character Read/Echo Module;

c. a set of logical error check modules; and

d. an Error Communications Display Generator.

Of these modules, the Display Generator and the Error Communications Display Generator make extensive use of tables. The data contained in these tables implement important program control functions.

The Display Generator is a generalized software module that prints display text on the Datagraphix terminal. Its major capability is to be able to print any text stored in a formatted disk file, thus separating text from a source program.

The Character Read/Echo Module will, as titled, read and echo a character(s) from the keyboard to the Datagraphix terminal. The module also provides cursor positioning, character delete, line delete, input escape, and no-echoing of excess input of characters.

The logical error check subroutines determine whether the user's inserted characters are valid with respect to the specific application. Identified error checks include:

a. WAC Validation;

b. Installation Validation;

c. GEO-ID/Validation Password;

d. Update Format Check;

e. Update Logic Check; and

f. Positional Parameter Validation.

The Error Communications Display Generator is a generalized

software module that prints error messages and 'Further Action' prompts on the Datagraphix screen. It is accessed when a user inserts an invalid response to a prompt or when 'shift ■ ' is entered in character input.

The on-line capabilities of the Air Facilities Subsystem are supported by special on-line programs, series of tables with software characteristics in function areas vital to the user, and interactive modules for the handling of basic display and input functions. The special on-line software is outlined in greater detail in the following paragraphs. It provides a program framework that enables the data base management functions of:

a. <u>System Security</u> with Log/on, Log/off procedures, GEO-ID/Password checks, and their correlations;

b. <u>Data Retrieval</u> from the AAFIF data base and display on a page-by-page, group, or element level;

c. <u>Updates</u> with extensive format and logical checks, including automatic updates (computed inputs); and

d. <u>Adds and Deletes</u> of the information for a whole airfield.

The programs for the on-line data base management system consist of the following modules.

a. <u>AFF - Air Facilities Executive</u>

The program AFF serves as the on-line Air Facilities executive and performs the functions of Log-on/Log-off. The interactive, on-line mode provides for a full repertoire of error checking of user-inserted data as well as a complete retinue of meaningful, diagnostic error messages with a unique steering capability to allow the user to act upon these errors.

The program initially asks the user to enter a GEO-ID and password. These values serve as "keys" to enter the program which then accesses a subroutine that asks a user to select a system function. The functions include ADD, DELETE, UPDATE, DISPLAY, RETRIEVE, and LOG-OFF. It will then initiate the execution of the selected function. Upon completion the user will have the option of re-selecting a function.

1. DISPLAY

The Display Subroutines permit a user to display and view selected contents of an Air Facilities record. The program initially asks the user to enter the WAC and installation numbers. These parameters serve to identify the record to be displayed. The program then asks the user to select the portion of the record that is to be displayed. The full record, a full category, a full subcategory of a category, specific elements, or a range of elements may be chosen.

2. UPDATE

The Update subroutines permit a user to update selected contents of an Air Facilities record. The program initially asks the user to enter the WAC and installation numbers. These parameters serve to identify the record to be updated. The program then asks the user to select the portion of the record that is to be updated. The full record, a full category, a full subcategory, specific elements, or a range of elements may be chosen. The program then sequences through the selected portion of the record. At each page the present contents of the data elements are printed and the user simply inserts the desired changes. These inputs are made subject to format checks with corrective actions requested by the system when necessary.

Text fields, due to their character lengths, are processed following the regular page update. Upon completion of this process, logical checks are performed that correlate the entered, new data with other data elements of the airfield. If correct, the update process will be completed by automatically writing the new data to the data base. Otherwise, the user will be notified by the system for remedial actions. Finally, the user is asked if another record is to be updated. If so, the above described process is repeated.

3. ADD

The Add Programs permit a user to insert or add a full Air Facilities record to the data base. The program initially asks the user to insert the record index parameters of WAC, installation

number, and coordinates. The program then pages through each page of elements of a subcategory of all categories. Due to their character lengths, text fields are processed following the addition of regular page element fields. Upon completion of entering a record the program will interactively ask if the user desires to enter another one. If so, the above described process is repeated.

4. DELETE

The Delete Subroutines permit a user to delete an Air Facilities data record. It is performed in an interactive, on-line mode. It provides for a full repertoire of error checking of user inserted data as well as a complete retinue of meaningful diagnostic error messages and unique steering capability to allow the user to act upon these errors.

The program initially asks the user to enter WAC and installation numbers. These parameters serve to identify the record to be deleted. The program then asks the user to enter or delete password. The user is given only three chances to correctly enter the password. Then the record is deleted and the user is informed via a display of such. The user may also delete a multiple element value; the field identifier is inserted followed by the multiple number.

5. RETRIEVE

The RETRIEVE programs permit a user to retrieve Air Facility records according to user specified parameters. It provides for a full repertoire of error checking of user inserted data as well as a complete retinue of meaningful diagnostic error messages and a unique steering capability to allow the user to act upon these errors.

The parameters are initially a table that creates a Boolean query logic. These tables are then delimited to the full data base, a geographic grid area, a WAC range, country range, installation range, or list of previously retrieved records. The program then will retrieve the records and pass them to an output module.

b. Error Messages

Two types of error messages may occur. The first is contained in the software itself and triggered by a most unusual condition tested for and implemented in a given subroutine. These error messages show up only in the case of a very unusual situation to indicate a system, table, or software error.

This is in contrast to the second type of error messages as produced by the Error Communications Display Generator. The latter are table driven and part of an elaborate Interactive Communications Package to achieve secure, flexible, and fool proof on-line operations.

The first type of error is program, table, or system oriented and should not occur at all in an operational system. (If it does, a more serious problem is indicated, requiring interventions of systems people or programmers.) The error messages are of the general form:

*** XXXXXX

with 'XXXXXX' standing for a specific message such as 'FORMAT TABLE MISSING.' They will be displayed on the screen starting at the current cursor position.

The second type of error is user-oriented, expected and planned for to provide a chance for pointing out and correcting input errors. Depending upon function and display layout, the computer generated question is sometimes just repeated upon receiving an invalid input.

In more complex situations a specific error message will be generated and shown at a communications control area, along with the options available to continue processing. The user need only enter the number that corresponds to the desired choice and the return key.

c. Security Processing

Using the log on provided by the AOS operating system and enhancing its capabilities by a "Middle-Man" filter program, the following security requirements are provided:

1. only AIS users maintain AAFIF Data Base;

2. only a Data Base administrator can delete airfields;

3. only ADA programmers can access AOS;

4. all others have "Read Only" access limited to their area of interest; and

5. the Master Console operator can monitor:

   (a) Terminal Activity;

   (b) Enable/Disable Terminals; and

   (c) Change Terminal Usage Priorities.

2.3.2.4.2 Data Dictionary. The AAFIF Data Dictionary provides interactive entry and viewing of air field data elements for the data base administrator. This function is the controlling mechanism of the data base content and structure.

The Data Dictionary provides a way to define and manage Air Facility information. Its objectives are:

a. define and store AAFIF element information on a schema/subschema level; and

b. provide for evolving AAFIF data content and editing via a data base language that consists of menu-oriented interactive software.

In order to obtain a high level, logical view of the data base, a series of menus and CRT displays are used in creating a DBL (Data Base Language). The task of the DBL is to convey, in a simple straight forward manner, the data base configuration. For example, if the data base administrator wanted to see the U. S. airfield configuration, all the inter-related elements that comprised it would be displayed.

Other information and processing that the DBL provides are:

a. a method to review data subcategories showing element name, description, number of characters, multiple, etc., etc. This provides an interactive data base definition analogous to APPENDIX C in the system documentation;

b. a method to review data inter-dependencies, and edits, and to change them; and

c. a method to add, modify or delete data elements (logical element configuration).

There are two major files used by the Data Dictionary. The first file is a Data Configuration File. It contains:

a. element name (i.e., GL01);

b. element description;

c. element size;

d. computed value indicator;

e. multiple indicator;

f. maximum number of multiples; and

g. card code.

It is used and is maintained for the purpose of reviewing and logically manipulating data elements.

The second file maintained is the COBOL File Description Library. Each AAFIF subcategory has its own library member. An example of this is shown below.

```
01  AT-SUB-CATEGORY

    05 AT11                 PIC X (620)
    05 AT12                 PIC XXX
    05 AT-MULT-OCCURRENCE   PIC 99
    05 AT-MULTIPLES OCCURS 1 TO 11 TIMES DEPENDING ON AT-MULT
       OCCURRENCE.

       10 AT01              PIC XXX
       10 AT02              PIC X
       10 AT03              PIC XXX
       10 AT04              PIC XXX
       10 AT05              PIC X
       10 AT06              PIC XXXX
       10 AT07              PIC X(6)
       10 AT08              PIC XXX
       10 AT09              PIC X
       10 AT10              PIC XXX
```

a. Application Programs

The Application Programs usually involve the processing of larger sections of the data base. For that reason a 'whole-sale' off-line processing during the off hours (nights, weekends, holidays) is indicated. Nevertheless, the on-line system is frequently used to initiate and to simplify those

off-line procedures (e.g., the on-line creation of Boolean search tables for the off-line processing of large SAIR requests).

The system output products are:

1. CRT displays of AAFIF content for analyst's review (local and remote);

2. extracted subsets (key files) of the AAFIF Data Base (these are used by application software);

3. SAIR/DAIR/184 Reports;

4. special and scheduled tape and printed report products from the AAFIF Data Base; and

5. ASSOTW/EBR Tapes for input to the Charting Subsystem.

The batch process functions of this system provide the output tape and hardcopy products. Due to the nature of the interactive software, all of the U1108 processing is either obsolete or modified in its data gathering methods.

The primary reasons for this software streamlining are two fold. First, a transaction activity log is maintained on disk in ascending date-time sequence. This allows the extraction of data base changes for any period of time (i.e., 2 days, 3 weeks, 1 month, etc., etc.). This file is used to produce WWMCCS, DIA, etc. output tapes. Secondly, the ASSOTW production will become more automatic and controlled by the AIS. As an integral part of the data base, an indicator is maintained to mark all data elements that changed along with a counter (displayed to the analyst) showing how many elements have changed since the last ASSOTW publication. This provides the analyst with information to be used to make a judgement decision on when an ASSOTW is issued. The ASSOTW log file is automatically maintained to mark those airfield records adjudged by the AIS to have ASSOTW significant changes. The ASSOTW applications program utilizes the ASSOTW log to determine which airfields are to be reported in the requested ASSOTW volume and to which section or index the applicable airfield information belongs.

b. Boolean Retrieval

The use of this function is depicted in the following scenario.

First, the ADA programmer envokes the software from a CRT; the existing logic tables are then reviewed. At this point, the user can refine an existing table or create a new one. The table is then "ran" against the data base in a batch mode. Depending on the results of the search, the user can either refine this table or continue with the next step. The extract file is then used as input to a batch application program that reads the data base and writes tapes or printed reports. An optional intermediate step can be included that sorts a user-specified field that is included in the extract file. For example, if a report is desired in alphabetical order by airfield name, those element(s) to be included would be specified on the extract file.

c. FORTRAN Interface

The interactive software (FORTRAN) required an interface to be provided to support blocked data base records with INFOS structure independance. The main functions of this additional software is to:

1. provide subroutines to replace the existing (PILOT software) INFOS manipulation logic;

2. return to calling program individual data elements;

3. provide the ability to decipher the data map associated with each variable length data base record.

4. interface with the PILOT interactive software in such a way as to minimize any changes; and

5. provide the "Hooks and Handles" to change the INFOS data base structure at any time with no impact on the interactive processing.

d. COBOL Interface

In order to support COBOL in an effective manner, and to provide data element name continuity, an interface is provided. The subcategory record lay-outs that are created and maintained by ADA programmers are used along with a Synectics-supplied COBOL module to support this feature. Its main function is to allow application programs to access the data base and acquire an entire subcategory's data elements at one time. An area of working storage (in a COBOL program) is defined 'as large as the largest subcategory to be accessed.'

This area is then redefined using the included (COPYLIB) record layouts. It is then a simple matter of calling the interface module to read a subcategory. The calling sequence consists of passing the subcategory code to be accessed and the group level name of the COPYLIB record for that subcategory to the subroutine.

e. Data Base Reconfiguration

In the process of adding, changing, or deleting data elements (on a schema/subschema level), it periodically becomes necessary to change the physical layout of the data base. After the logical definition and manipulation is completed (using the interactive Data Dictionary), this system function is utilized. The actions performed by this process include changing every airfield that has the modified data elements and ADA programmers changing the appropriate COBOL COPYLIB record descriptions. Because of the nature of these operations, this function executes in a batch environment and requires exclusive use of the M-600 system.

f. Transaction Activity Log/AIS Activity Report

In order to provide management control and an information audit trail mechanism, a transaction activity log is maintained by the software that can report system use for activity history and analysis. The report provided in the PHASE-II design is the AIS report. This report is produced daily and is used to visually verify the previous day's transactions (by the AIS). It is sorted and paginated in such a way that it can be decollated and each AIS will get an individual report. The information on the report is:

1. AIS analyst code;

2. identification information for airfield;

3. any change to a subcategory will produce a print of the entire subcategory;

4. data content before change;

5. data content after change; and

6. date and time change made.

2.3.3 Charting

The Charting Subsystem of the Automated Air Information Production System (AAIPS) is tasked with the capture, revision, and output of graphic data appearing throughout the DMAAC Flight Information Publications (FLIPs). Consistent with the time-saving purpose of all three subsystems, the Charting Subsystem achieves its goal by the preservation of data in digital form and providing techniques to effect the simplicity of alteration of the data.

The subsystem is required to support the creation and maintenance of a FLIP graphic data base which is further exploited to generate other FLIP products. The Charting Subsystem also accepts data from the Publishing and Air Facilities Subsystems, merges charting data with textual data from the Publishing Subsystem, and generates film positives through the Electron Beam Recorder (EBR).

The subsystem provides interactive data acquisition/revision, EBR data processing, EBR control processing/recording, EBR symbol/text library maintenance, charting data base maintenance, and EBR graphic data base maintenance. The three major functional areas are: Interactive Data Acquisition, EBR Data Preparation, and EBR Control Processing. Reference Figure 2-16.

The Charting Subsystem is designed and implemented in a functionally modular fashion with each operation performed having a very discrete result. Well defined functions are implemented which, under operator control, can be linked together to accomplish very complex digitizing or editing functions. The system is menu-driven with the menu containing thirteen (13) functional capabilities which are divided into 162 subfunctions or operations.

2.3.3.1 Capabilities

In the Charting Subsystem the following capabilities are available:

a. A digitization capability that will permit a smooth finished quality graphic to be produced from a rough hand drawn sketch. An operator may perform the following operations:

    1. define a single line between two points at a scale determined by the operator;

    2. trace free form lines while the system records the line points;

    3. construct lines, arcs, and circles as dots, dashes, or solid lines;

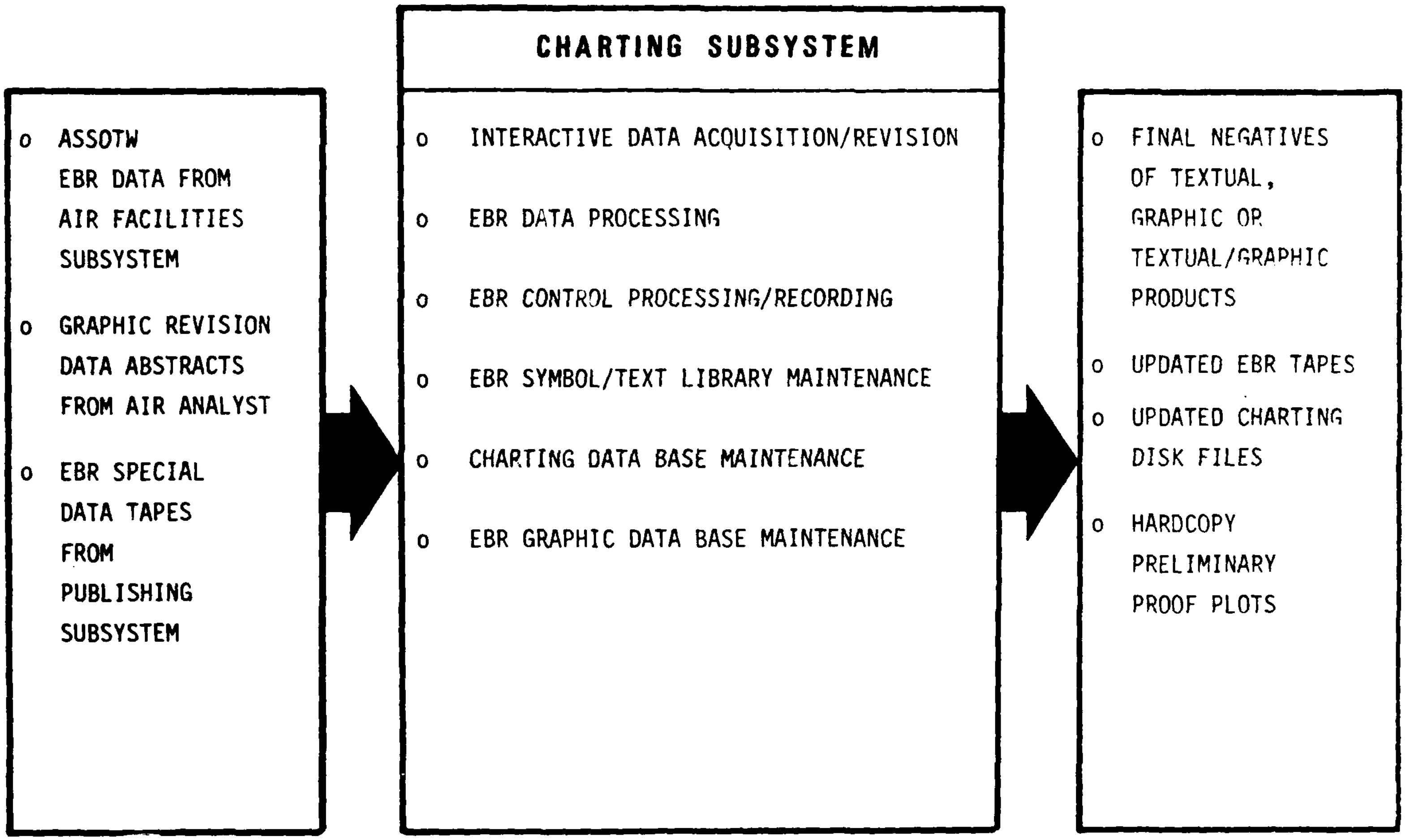

Figure 2-16. Charting Subsystem Functions

4. designate one or multiple straight line [illegible] by digitizing only the end points;

5. intermix straight line segments and [illegible] to define a complete feature;

6. digitize a rectangle by entering the [illegible] opposite corners;

7. digitize a circle by either entering [illegible] and a point on the circumference or by [illegible] any three points on the circumference;

8. digitize an arc by entering the end [illegible] the arc and entering its center point [illegible] entering a midpoint on the arc; or

9. smooth the display of arcs and circles by increasing the number of displayed points.

b. <u>The capability to edit graphics</u> that were previously digitized. The types of changes include delete, change or add more lines, symbols, text, or entire drawings. Edits may be invoked by menu at the digitizer and include the following operations:

1. delete all data in sections outside a designated area;

2. define and make location changes to points on a line;

3. define and move text and symbols;

4. define and simultaneously move all lines, points, text, and symbols in a designated area to a new area;

5. move any and all points;

6. any previously digitized point may be found by the operator indicating the approximate location of the desired data and the system will perform the search over the entire format or to an operator devised area of interest; and

7. apply curve smoothing by presetting the smoothing threshold to the desired value.

c. Registration of a drawing (if not aligned with absolute coordinate frame) by indicating control points. The system automatically generates coordinate transformation coefficients for each registered drawing. All digitizing coordinate values are transformed by these coefficients until they are implicitly changed by a new registration. The coordinate transformations correct for scale, translation, and rotation.

d. The ability to digitize the drawing origin if different from the digitizer origin. The coordinate frame for all data in the drawing file is relative to the drawing origin rather than the absolute origin and the absolute coordinate frame.

e. The ability to select the recording resolution by allowing different levels of grid spacing.

f. A graphic display capability to permit the operator to display the contents of either the drawing or scratch file. The current image of the original drawing remains on the screen (despite new changes) until the erase control mechanism is activated which clears the display screen. The operator may select any retangular area within the registered drawing file by cursor pointing and the area is brought into view on the display scaled to span the whole screen area. Alternatively, the operator may indicate a single point and the neighborhood of the point will be displayed on the screen at drawing scale.

g. An efficient text entry and placement capability by utilizing the digitizer for positioning and the keyboard for text entry which includes the following capabilities:

   1. the size of the text may be varied explicitly through a keyboard entry;

   2. the text string may be rotated through $\pm 360^0$;

   3. for symbols containing variable text, the system requests the operator to enter the text, which is then positioned within the symbol at the proper relative position; and

4. the display of text over the whole screen is operator selectable; the text display is disabled automatically if the drawing scale renders the text unreadable.

h. Efficient symbology creation, selection, and placement which includes the following capabilities:

   1. support a symbol file of up to 500 symbols and permit selection of any symbol for placement;

   2. digitize finished quality symbols for the operator's own user symbol file without disturbing the drawing file;

   3. vary the symbol scale by operator selection;

   4. rotate symbol through $\pm$ 360°;

   5. generate mirror images of symbols about the vertical axis;

   6. provide five levels of nesting for creation of new symbols which contain other symbols; and

   7. allow a symbol to be repeated between any two points on/or along area boundaries or circumferences of circles automatically.

i. A flexible and efficient file management mechanism which permits the operator to have simultaneous access to three files (drawing, scratch, and symbol) at all times. The drawing file is the repository for the drawing that is currently being manipulated. The scratch file is the repository for a new or temporary symbol, while permitting data in the main drawing file to be undisturbed. A symbol file can contain a maximum of 500 symbols (300 standard and 200 user symbols). The following file handling capabilities are provided:

   1. segregate drawings into layers (subfiles) up to a maximum of 32 separations;

   2. select a new drawing or symbol file at any time;

   3. selectively display the contents of the drawing or scratch file;

4. clear the contents of the drawing or scratch file;

5. convert the contents of the drawing file or scratch file into a symbol and store it into the symbol file;

6. retrieve a symbol to the drawing or scratch file for modification;

7. generate on the hardcopy unit a list of coordinates and status of all arcs, lines, circles, and text for the drawing, scratch, and symbol files; and

8. permit a new drawing to be digitized while another drawing is being output to the Charting Subsystem output device.

j. Output processing that can search the Charting Subsystem data base at product cut off time and retrieve only those files that have been revised since the last product cut off. For each chart retrieved, a hardcopy printout consisting of the chart identification, total number of revisions, and number of revisions for each color separation is provided.

k. A final output capability via the Charting Subsystem output device which produces final composite ready-for-production film negatives as follows:

1. accepts formatted magnetic tape data files from the Publishing and Air Facilities Subsystems to produce textual output;

2. produces graphic output prepared by the Charting Subsystem; and

3. merges data from the Charting and Publishing Subsystems to produce combined text and graphic outputs, in which the text and graphics may be either side by side on a page or on entirely separate pages.

l. A restricted access log-on procedure to assure only authorized use of the digitization stations.

2.3.3.2 Design Criteria

The primary, controlling precept in the design of the Charting Subsystem was that it must support the acquisition, modification, and output of any and all graphic image data occurring throughout the spectrum of FLIP publications. While many of the FLIP products are or can be treated as pure graphics (and therefore handled entirely within the Charting Subsystem), several of the document types are primarily textual and must be processed by special techniques in the Publishing Subsystem. This situation then created the additional Charting design requirement that a data and procedural interface be established to merge components from two widely dissimilar data bases. The solution derived was to have the Publishing Subsystem be the controlling process, calling for graphic inserts (previously created by Charting and residing in the Charting data base in EBR tape format) to be merged with Publishing text which has also been converted to EBR tape format. The possibility of adding a second tape drive to the EBR PDP-11 controller and modifying the controlling software to combine the two data sources in real time was rejected because of the difficulties of maintaining the proper sequence and synchronization of data from two subsystems which act independently until data-merge time. In the method used, Charting data may be retrieved randomly from the disk unit so that the order dictated by the Publishing tape at run time is accomplished. In the event that a requested graphic does not exist in the Charting data base, a default "empty box" is substituted.

The second major design criteria was that the Charting Subsystem must be capable of supporting the full production work load with a minimum replication of hardware (beyond the Pilot configuration) while supporting subsidiary processes with any system resources (memory, disk space, etc.) not required by the principal function of graphic data capture and revision. Also, execution of subsidiary processes must not noticeably degrade the principal function by causing the graphic-compiler/operator to wait for service any more than if the subsidiary function was not executing.

2.3.3.3 Subsystem Data Base

The Charting Subsystem Data Base exists in two distinct forms, namely:

a. the set of files on disk packs containing chart imagery or supporting the acquisition or revision of chart imagery; and

b. a library of magnetic tapes in the Electron Beam Recorder drive format containing chart data current to the last previous publication date for each product

type. This library exists solely to avoid re-conversion of data (to EBR format) which has not changed since the last publication cycle of a product.

Only the general structure and use of these files will be given in this document since the details on record formats and content are discussed fully in the Programmer User's Manual for the Charting Subsystem. Except as noted, all disk files are random access, variable-length logical records, accessed by physical block of 512 bytes.

<u>2.3.3.3.1 Digitizing/Editing station disk files</u>. Physical disk space is logically divided into a variable number of sub-areas known as directories. The primary directory (DZO) holds several utility files which are used for all types of products, while the sub-directories each contain files pertaining only to a single product type (e.g., low enroute, high IAP, general planning, etc.). The subsystem structure supports the addition of any number of sub-directories and each sub-directory can expand or contract as required, limited only by the total disk capacity of 192 M Bytes. The types of data files used are listed below.

a. <u>Drawing Files</u>

These are random access files located within sub-directories, each of which comprise a single graphic entity such as one SID, one chartlet for the VFR Supplement, one side of an enroute chart and so forth.

The first physical record (Block 0) is a fixed-length parameter record which maintains information pertaining to the digitization/editing process (chart origin coordinates, registration co-efficients, selected line weight, selected symbol number, etc.) such that a work session on the drawing may be interrupted temporarily and resumed later with all conditions established by the operator remaining intact. All subsequent records (Blocks 1 through n) contain logical descriptors of features, variable in length, in six classes.

1. PATH

2. AREA

3. FIXED TEXT

4. VARIABLE TEXT

5. STANDARD SYMBOL REFERENCE

6. USER SYMBOL REFERENCE

PATH and AREA (boundary) data are both lineal in nature; composed of absolute coordinate points, vector strings, or arc/circle specifiers, all of which may be intermixed. Vector data is generally acquired by tracing features of a complex character.

FIXED TEXT and VARIABLE TEXT (the latter is used only with USER SYMBOLS) record types specify characteristics of a string of text: position, angular orientation, justification (horizontal and vertical), color/screen, and font style. Four font styles are available, but a maximum of 254 may be accommodated. Multiple-line strings are handled automatically by stepping along the normal to the base-line angle each time a carriage-return character is found in the text string.

USER SYMBOL and STANDARD SYMBOL reference records are similar except that a User Symbol reference may contain a Standard Symbol reference but not vice versa. Both call for the placement of a predefined "mini-drawing" within the final (film) image at a point, along a path, or filling an area.

b. Revision Index Files

One Revision Index file exists in each product directory. They are random access files, blocked 32 words per logical record. Each record contains the name of one drawing file in the product directory, a single-word "bit map" of which color/screen groups in the drawing have been edited or added to since the last previous publication cycle, a cumulative time (minutes) expended creating or editing the particular drawing, and a cumulative count of revisions performed. Also, if the drawing is not one which has been newly created since the last publication date, the logical record also carries the magnetic tape reel number (on which the EBR-format data is stored) and a list of "image numbers" (file numbers) of the various color/screen separations within the tape. Whenever a new publication cycle is run, the reel number and image number list is updated appropriately and all bits in

the C/S bit map word are cleared indicating that the archival tape contains the latest information. Further editing of any part of a drawing again sets bits in this word such that the next run will re-process the changed portions.

c. Symbol Files

These files reside within the sub-directory USYMB and are collections of "mini-drawings" in the same data format as described for the main drawing files except that the first block is an index correlating a particular symbol number to a disk address. Their purpose for standard symbols is solely the displaying of an approximate representation of a pre-defined image on the operator's terminal, since later creation of the film image on the EBR uses only the symbol number (stored in a symbol reference record in the main drawing file) to access a library of precision images stored on the EBR/PDP-11 disk units. However, since the operator has the capability to create compound "user symbols" incorporating both standard symbols and other linework for repetitive recall, the ability to create personal symbol files (stored in the same USYMB directory) to retain such work for subsequent editing/digitizing sessions is also given. Each symbol file may contain 300 standard symbols and 200 compound user symbols; there is no limit on the number of symbol files residing in USYMB except total disk space.

d. Log File

This file is used only for logging onto the subsystem and gaining access to files; not for identifying any link between data files and a particular operator or group, or for establishing any sort of system security.

e. Message File

This is simply an external list of most of the error messages and help prompts used in the subsystem. Use of an external file instead of embedding messages within subroutines allows easy modification of formats and use of any message by multiple program modules.

f. Grid Area Index File

To accommodate rapid editing access to any particular feature, this file is a tabulation of disk address

for feature lines passing through each of 10080 grid areas (120 columns x 84 rows, one half inch spacing in both dimensions). The file is blocked at 15 words per logical record, to allow seven (7) block/word address pairs for each grid area, plus an overflow link in case more than seven (7) features pass through any grid square. Overflow records are also 15 words long, so that a grid containing parts of more than 14 features would overflow to a third record and so on. Typically, few grids contain more than seven (7) features and therefore, each usually requires only one block.

When an operator initiates a search for a feature (for editing) the coordinate location of the cursor establishes the grid area and therefore the chain of index blocks to be used for candidate features. Each feature is examined in detail for a match to a color/layer mask and search tolerance (distance) established by the operator; any feature meeting these criteria are listed on the station Dasher terminal (parameters and x, y coordinates) until aborted by the operator.

g. Font Files

Similar in use and structure to the symbol files, these font files exist only for the digitizer operator's display terminal presentation of alphanumeric strings in approximate proper size, style, and orientation. A total of 254 font or symbol files may be employed by the subsystem. Each font file may contain up to 128 characters.

2.3.3.3.2 Electron Beam Recorder Tape Library. This library is maintained to avoid the reprocessing of graphic data which has not been altered since the last publication of a product. Each graphic entity which is to appear on a separate film image comprises one tape file. All records in the file are fixed at 2048 words in length except the last, which may be as short as necessary. The first three (3) words of each record are control words identifying image number (file number), page number (a selectable subset of an image), and record number (within the page). The remaining words in each record fall into two (2) categories.

a. Command words

1. Set beam intensity (64 steps)

2. Set line weight (6 microns to 6138 microns, 1023 steps)

3. Set font number

4. Set character size

5. Set character (string) angle

6. Enter ASCII mode

7. Enter Incremental Vector Plot mode (not used in Pilot system)

8. Enter Vector mode

9. Set Point x & y (Move with beam off to new absolute position)

10. Relative move x & y (with beam on)

b. Data strings

1. ASCII characters, two per word, output under conditions established by command words.

2. Incremental Vector steps, four per word, six micron steps in eight possible directions (not used in Pilot system).

Note that standard symbols are ASCII characters within Font 1, and that additional fonts may be established if the need arises.

2.3.3.4 Subsystem Software

The Charting Subsystem software consists of three (3) packages to perform:

a. interactive graphic data acquisition and revision;

b. conversion of graphic data to Electron Beam Recorder drive tape format; and

c. merging of graphic data with Publishing Subsystem textual data to produce a single EBR drive tape.

2.3.3.4.1 Interactive Graphic Software. The first of these packages, for interactive graphic manipulation, consists of a main (executive) routine and 88 subroutines (organized functionally into 23 overlay modules) and one group of core-resident utility routines. Detailed documentation and flowcharts for all subroutines can be found

in the subsystem Programmer's Manual, and will not be repeated here. The major functions of the 24 groups are as follows:

a. Executive module accomplishes:

   1. digitizing table servicing including recognition and interpretation of cursor keys and cursor x, y position;

   2. correlation of cursor key/position to desired function; and

   3. overlay module load and call (execute).

b. Log-On module:

   1. accepts User identification and password character strings; and

   2. verifies legitimate identifiers or aborts station initialization.

c. Directory/File Initialization module:

   1. accepts directory (product type) name, file (drawing) name, and symbol file name;

   2. if directory and file named exist, copies that file to a temporary (working) version and builds a grid area feature index; and

   3. if directory and/or file do not exist (and operator confirms that new desired) establishes new symbol file with no content.

d. Registration control module functions:

   1. menu origin select;

   2. chart origin select;

   3. registration correction computation; and

   4. registration verification.

e. Resolution control module:

   1. establishes grid round-off and trace resolution spacing.

f. Path type control module:

   1. line type select; and

   2. line thickness select.

g. Shading control module:

   1. area, text, path, and symbol shading select.

h. Text type control module:

   1. font style select;

   2. variable text on/off select;

   3. font size select; and

   4. horizontal & vertical justification select.

i. Text rotation control module:

   1. 0°, $+90^{\circ}$, or -90° rotation select;

   2. manual rotation select (any angle); and

   3. analog rotation select (any angle).

j. Symbol rotation control module:

   1. 0°, Manual, or Analog rotation select.

k. Symbol type control module:

   1. symbol scale select; and

   2. mirror on/off select.

l. Edit control (three overlay modules):

   1. layer/separation select;

   2. search tolerance select;

   3. locate feature;

   4. display and list feature;

   5. modify feature header;

6. delete feature/text;
7. move text;
8. move point symbol;
9. delete point symbol;
10. delete inside section;
11. delete outside section;
12. move section; and
13. modify root, prefix, or suffix segment of feature.

m. Separation/Layer control module:

1. separation and layer select for digitizing.

n. Display/List control module:

1. circle/arc roundness select;
2. text display on/off select;
3. grid display on/off select;
4. layer/separation (display/list) select;
5. window area select (1:1 or auto-scaled);
6. trigger hard copy of screen content; and
7. cased text on/off select.

o. Job close control module:

1. close files and log-off on fatal error or operator command (confirmed).

p. Symbol display module:

1. display point, left-path, right-path, left-area, right-area symbols; and
2. handle nesting of user symbols, with or without variable text.

q. Digitizing control (two overlay modules):

1. select/establish feature type: path, area-left, area-right, fixed or variable text, point symbol, path symbol left or right, area symbol left or right; and

2. select/effect data type: trace, rectangle, circle, cw arc, ccw arc, line/point, polynomial smoothing of degree 2, 3, or 4.

r. File control (four overlay modules):

1. clear work file;

2. clear scratch file;

3. store work or scratch file as symbol, and clear;

4. recall symbol to work file, normal, or shifted position;

5. recall symbol to scratch file, normal, or shifted position;

6. store current drawing file and open/establish new;

7. establish new symbol file;

8. display work or scratch file; and

9. list drawing, scratch, or symbol files.

All of the interactive graphic software is written in FORTRAN 5 with the exception of two routines which handle communications with the digitizing table, Tektronix display terminal, and station Dasher hardcopy terminal.

2.3.3.4.2 EBR Drive Tape Creation Software. The EBRDC software package consists of a main (executive) routine and 49 subroutines organized functionally into 20 overlay modules. Each execution of the package processes all drawings in a single product directory. Eight (8) of the modules are considered "level 1" functions and perform one-time-per-run or one-time-per-drawing operations such as:

a. initialize output magnetic tape, and input tape if operator indicates an archival tape exists from a previous run;

b. initialize program arrays/areas/variables, initialize directories, and open files applicable to entire product directory;

c. build a temporary image index file for product directory;

d. examine each drawing file and create a temporary index to features within the drawing;

e. copy images of a drawing (color/separation) which have not been altered since a previous run against the directory;

f. cycle through each drawing calling "level 2" modules to convert data within the drawing to EBR format; and

g. wrap-up a run, outputting final data blocks, closing files, deleting temporary files, etc.

The level two (2) software consists of 12 overlay modules, three (3) of which process line-path, area, and textual data to EBR form. A fourth level two (2) module is basically a dispatcher routine to load and call one (1) of the nine (9) remaining modules, each of which processes one (1) to three (3) of the eleven (11) classes of symbols currently being used on FLIP products.

The entire EBRDC package is written in FORTRAN V and requires slightly less than 30K words of memory and at least one (1) tape transport for execution.

2.3.3.4.3 Chart/Publishing Data Merge Software. This package is actually two sequential processes. The first, known as EBRLOAD, transfers the contents of an archival EBR tape to the S/230 disk drive in a product directory specified by the operator. The names of the disk files created correspond to the sequence in which the files are found on the input tape. Other than system library routines, only one small subroutine is used. The input tape is dismounted and replaced by the tape from the Publishing Subsystem, and the second-phase process is executed to perform the merge and write a complete output tape with both text and graphics.

The second phase, EBRMERGE, consists of a main routine and six subroutines. Together this software:

a. copies textual data records from input to output tape until a "graphic call" record is found in the input tape;

b. opens the appropriate disk graphic file and determines from the "call" record what scale, rotation, and origin shift is to be applied to the graphic. (Scale and rotation are constant for a product type);

c. if the requested graphic does not exist for any reason, one subroutine is used to substitute a "null" empty box at the specified location; and

d. two subroutines create or alter EBR command data words as they buffer the graphic data to the output tape.

All of the software for the merging process is in FORTRAN V. Figure 2-17 depicts a typical data flow for the preparation of EBR tapes as described above.

2.3.4 AAIPS Cartographic Electron Beam Recorder

The AAIPS Cartographic EBR system fabricated by Image Graphics, Inc. under subcontract to Synectics Corporation is the principle cartographic output device of the Charting, Publishing and Air Facilities subsystems.

The EBR was selected as the AAIPS output device because it is capable of high speed, high quality, and versatile plotting/recording. Digital data is converted by the EBR into images on electron sensitive film. The EBR provides a method for creating the final separation negatives in conjunction with existing production equipment. The EBR possesses the accuracy, resolution, and flexibility to produce graphics art quality recording output consisting of line, point, area symbology, and multiple fonts required by the Flight Information Products.

The EBR is a complete stand-alone system supported by a DEC PDP-11/341 central processor with 64K 16-bit word core memory, automatic power fail detection/restart and direct memory access interface. Peripherals include a 9-track TE16 800/1600 bpi, 45 ips magnetic tape transport/controller, an RK11 dual disk drive supporting two 2.5 Mbytes RKOJJ disks, and an LA36-CA decwriter console terminal.

The data translator circuits of the EBR are contained in the Symbol/Vector Generator (SVG) which converts digital data from the computer into analog signals which drive the EBR. The SVG performs character and symbol generation, incremental and stroke vector recording, variable line width control, variable character size and orientation variable intensity control for gray shade, and random X-Y positioning.

A Tektronix 619 storage display is provided to allow direct running of the data being plotted by the EBR.

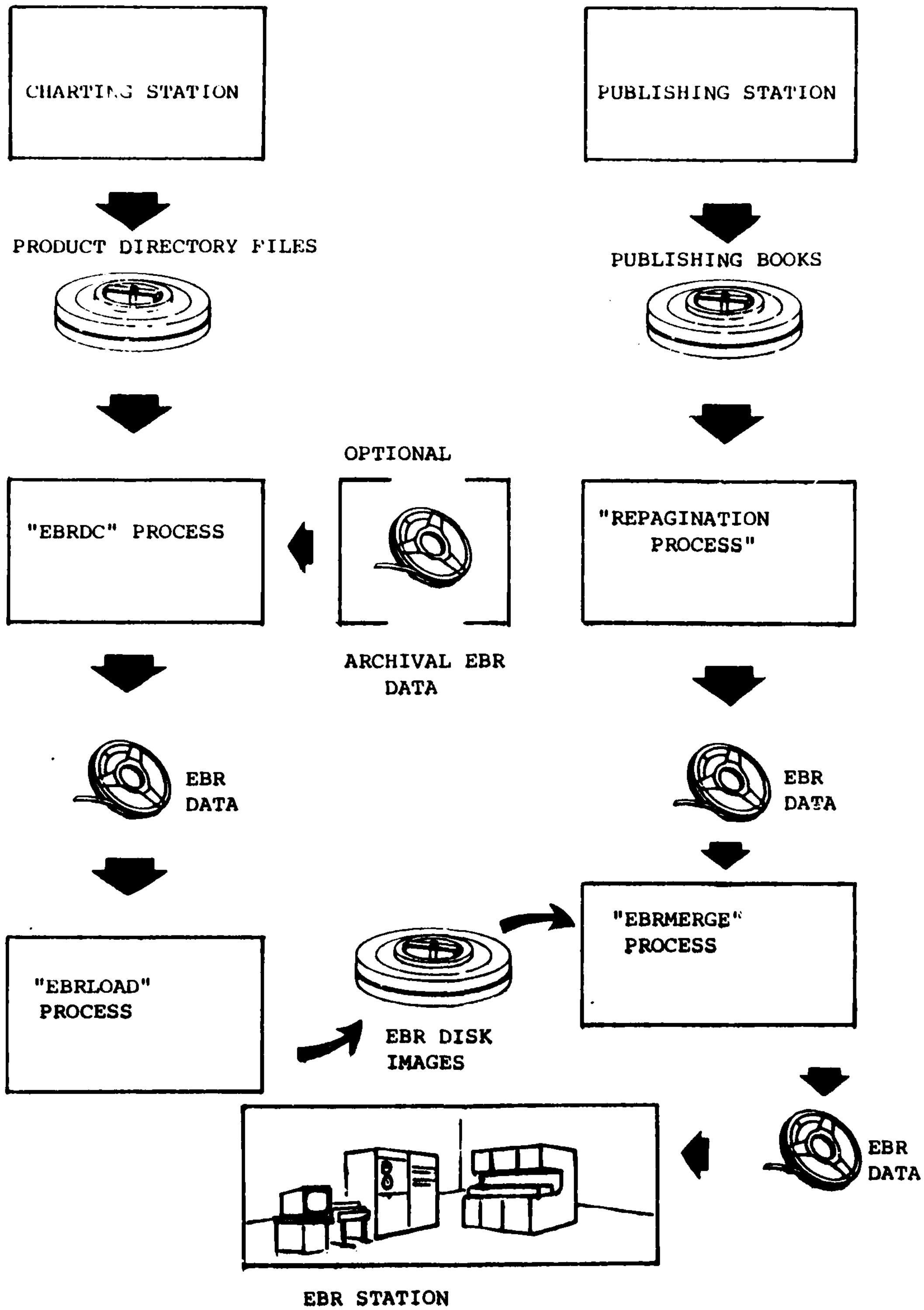

Figure 2-17. Charting/Publishing Data Merge Flow

TABLE I

TYPICAL CARTOGRAPHIC EBR SYSTEM PERFORMANCE CHARACTERISTICS

Film Type	Kodak SO-219 unperforated
Film Size	5-1/2" wide
Film Capacity	100 Feet wound on 3" diameter cores, emulsion side out
Film Transport	Single/frame pull down with registration punches
Registration Holes	Two 1/4" holes, 9 inches bounding each frame
Film Pull Down	5 secs
Minimum Line Width	6 μm
Variable Line Widths (EBR Image Scale)	6 to 261 μm with 8 bit (256 levels) control, in 1 μm increments
Character Sizes (EBR image scale)	8-250 mils
Character Rotation	1^{o} Increments
Beam Position	19,859 x 32,768 address matrix over a 5" x 8-1/4" format area
Congruity of sequential images	$\pm$.003% of full size of image
Geometric Fidelity	$\pm$.01% (with software correction) $\pm$.05% (without software correction)
Maximum optical density	2.35+
Line density range (gray shades, discernible steps)	64
Background density	0.1 density unit
Video Bandwidth	DC - 10 MHz
Writing Speeds	
Random Points*	40K points/sec
Adjacent Points (VIP)	120K points/sec**
Stroke Vectors	10K points/sec
Character Generation Speeds	1K

(Characters per second at EBR scale)

8-250 mils (Graphic Arts) characters/sec (AVG)***

AD-A096 436 SYNECTICS CORP FAIRFAX VA F/G 9/2
AUTOMATED AIR INFORMATION PRODUCTION SYSTEM - PHASE II.(U)
OCT 80 R P O'CONNOR, N A BOTTINI F30602-77-C-0065
UNCLASSIFIED RADC-TR-80-323 NL

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SECTION 3. TRAINING

3.1 REQUIREMENTS

Training for ADP systems analysts, programmers, and operators was provided as part of the overall contract obligation. Training was provided at DMAAC/AD and included all aspects of the full system operation. Type and scope of training to be provided as required by the contract was as follows:

a. Training for systems analysts covering computer operation, operating systems, compilers, assemblers, loaders/linkers, libraries and other support software;

b. Training for programmers would include familiarization with the system operation and emphasize the applications software provided; and

c. Training for operators would include both formal classroom instruction as well as hands on system demonstrations.

3.2 TRAINING PROGRAM

Prior to conduct of the training, complete training course outlines were prepared by Synectics and reviewed and approved by appropriate Government personnel. The course outline provided specific details for the agenda, required materials, personnel attending, instructor staff, and topics to be covered.

Training was conducted over a continuous seven week period, 4 hours per day to minimize the interference with usual AD production schedules. Training was provided on a subsystem basis. In most instances DMAAC/ADA programmers and analysts attended both the training for systems analysts and programmers for all three subsystems. Extensive training aids in the form of briefing handouts and computer listings were provided. Training required intensive participation by the trainees. Each formal instruction session was followed by classroom quizzes, which provided necessary feedback to instructor personnel. Remedial review of difficult subject matter was performed immediately before moving to the next session. Systems analyst training required the participation of trainees in a design workshop. Subsystem-related problems were presented and trainees were required to employ modern structured design techniques to outline

design subsections. Programming assignments were similarly made to stimulate creative utilization of the plentiful software development tools provided by each subsystem.

The training program attempted to bring to light the potential capabilities inherent within the AAIPS. Strict separation of major personnel functions and rules was not emphasized because fine training of personnel functions will undoubtedly take place in time as management perceives the need to establish them.

SECTION 4. TEST AND EVALUATION

4.1 CONCEPT

The AAIPS system acceptance and evaluation tests were performed to demonstrate the AAIPS capability to meet or exceed all specific SOW requirements.

A comprehensive system test and evaluation plan for Phase II was prepared to fulfill the following objectives:

a. provide concise evidence of the system's capability to accomplish the SOW requirements;

b. serve as a guide for management by objectives to ensure a thorough step-by-step validation of the system's functional/operational capabilities;

c. coordinate for all test personnel a schedule of events, specification of equipment and organizational support, test methodology, and definition of specific test procedures; and

d. to provide a written record of requirements and evidence of their satisfaction.

The test procedures can be categorized in the following way:

a. Demonstration tests - which require furnishing evidence of satisfaction of a system attribute by either direct hands-on operation, provision of vendor literature, or physical inspection;

b. Functional tests - which requires independent testing with a confirmed input and output. Interrelated functions may be tested when individual functions cannot be tested independently. The input/output may be verified by softcopy display, plot, hardcopy print out, EBR film positive, etc; and

c. Volume Throughput tests - which involves full subsystem testing in a pseudo-production environment where the success criteria is based on processing a prescribed volume of data in a particular span of time.

In order to assure complete traceability of all test events and milestones to the contract SOW, a SOW Cross Reference Matrix was provided within the test plan. As each test item was accomplished the particular SOW requirement tied to that particular test was signed off by the appropriate Government witness.

The primary purpose of the Test and Evaluation was to determine the capability of the system to support full production. Functional and demonstration testing was to be conducted for each subsystem during 1 October 1979 through the T&E period until all tests were successful. Full production volume T&E was conducted from 1 November 1979 through 28 December 1979.

The execution and evaluation of all functions during the T&E period was performed by DMAAC personnel. The DMAAC personnel was responsible for recording all the necessary data to permit subsequent evaluation of the system.

All demonstrational and functional tests as prescribed by the Test Plans and Procedures Volume I, II, III, and IV were performed successfully and witnessed by Government test director personnel.

4.2 AIR FACILITIES SUBSYSTEM

The full AAFIF file was transported from the U1108 and loaded onto the Air Facilities Subsystem disk mass storage. The full production testing required that real-world transactions would be used to update the AAFIF via the on-line data terminals. One day of real-world transactions would be performed for each working day of the T&E. The data base maintenance would be performed by the Aeronautical information specialists (AIS) in DMAAC/ADA who had previously been given a rudimentary training orientation. During the seven weeks of T&E, DMAAC/ADA personnel produced daily listings of the systems utilization log to verify AIS performance with respect to the volume input. Each T&E data base update transaction was captured by the interactive software and maintained in a log file. Hardcopy output of old and new contents of each updated element was obtained by the daily printouts. This output was used to verify the acceptability of the subsystem to support the volume input.

The interactive data base maintenance capability achieved an average revision time of less than 2 1/2 minutes per element update. As such the 16 terminal configuration provides more than ample capacity to support full production AAFIF maintenance.

The data base maintenance function is supported by the capability of the subsystem to provide AIS positive feedback reports. These are hardcopy reports of full or partial airfields that have been changed by the AIS and are automatically generated upon request by the AIS. The

reports are generated following the prime shift when all data base maintenance activity is completed for the day. A spool file is generated and may be printed the following morning and distributed to AIS personnel. The throughput for this function during T&E probably represented a worst-case since it is anticipated that the AIS will gradually acquire greater confidence in the softcopy display for review and not rely as heavily on the hardcopy reports. Nevertheless, the spooling process averaged less than 2 hours and the printing required about 1.2 hours each day.

The testing involved all normal production activities that would necessarily be encountered in full production. This included daily maintenance of the AAFIF Card Image File and AAFIF Mini File. These auxiliary files are derived from AAFIF information and are maintained by special data base applications programs. These files were provided to ensure greater throughput of the AAFIF application programs.

The Card Image File is equivalent in format to the current U1108 AAFIF file and is used to produce history tapes having the same format as those produced by the U1108 HISTDUP program. The card image file and its index resides on 4 disk packs and occupies a space equivalent to the capacity of 3 full disk packs.

The card image file is built on a one-time-only basis by a special program which converts the entire AAFIF information to card image format on disk. During the T&E the card image file was generated in 251.5 hours of elapsed wall clock time. Daily maintenance of the card image file which utilizes the transaction log as input averaged 1.3 hours per day.

The other major auxiliary file is the AAFIF Mini file which consists of subsets of significant data base elements extracted from each airfield record and organized by airfield installation sequence. The mini file occupies less than 5 percent of a single disk's capacity. The daily maintenance of the mini file which is performed by special applications software averaged less than 5 minutes.

The daily maintenance of the auxiliary files must precede all other applications programs job streams that require the card image file or mini file inputs.

The applications program throughput testing involved four typical AAFIF output processing programs.

The HTAPE program which outputs the card image file information to tape in the HISTDUP format constituted a significant part of the volume testing. The success criteria demanded that a complete card image file be recorded on tape within a fifty-four hour period (i.e., the time available for processing over a week-end). The actual test results realized output of the complete card image file on 23 reels of tape in less than 42 hours of elapsed wall clock time.

The AFFUPDT program produces the DIA transaction tape file. Fixed element transactions and variable text information from the transaction log combined with primary AAFIF file information was used to produce the DIA tape. This weekly production program averaged less than 1/3 hour of wall clock time per run during T&E. The success criteria for the AFFUPDT throughput was established at 4 hours per run.

The AFFINDEX program which produces a hardcopy report of relevant AAFIF index information averaged less than 3 hours per run during the T&E period. Success criteria for this program was established prior to the test at 8 hours per run.

The ASSOTW program which produces EBR tapes for subsequent EBR recording of film images of the ASSOTW report averaged less than 3/4 hour per run during the T&E. Success criteria of 30 hours per run had been established prior to the testing.

The T&E testing proved conclusively that the Air Facilities Subsystem as developed during Phase II provides sufficient storage capacity and processing performance to support full production.

4.3 PUBLISHING SUBSYSTEM

Prior to the T&E period a representative FLIP textual test data base was acquired. The products included: PAA enroute supplement; Area planning/3; Area Planning/3A; US VFR supplement; and document MAN's and PCN's. A pseudo production schedule spanning three hypothetical information cutoff dates was established. Revisions were performed on the basis of three "real-world" days of transactions for each day of T&E. The product maintenance was performed by DMAAC text composers who had become quite familiar with the system but technically had not received any formal training. On the ICOD data all applicable products were repaginated and recorded on the EBR. Products that required merging with graphics produced by the Charting subsystem were similarly prepared for EBR recording. Film processing was performed in the DMAAC/GA photo laboratory and lithos were produced for evaluation purposes.

4.4 CHARTING SUBSYSTEM

The test data base for the Charting T&E included the following products: 12 PAA enroute charts, 4 African enroute charts, as many PAA IAP's as practicable (digitization of new IAP's continued throughout the T&E period but digitization times were not counted as part of the T&E), 26 AFR IAP's and 30 pages of the US VFR Supplement. The graphic FLIP

production schedule was divided into three simulated maintenance cycles with the same information cutoff dates as used for the Publishing Subsystem. The revisions were performed by trained but relatively inexperienced aeronautical chart maintenance specialists. The data abstracts (DA's) which specify the particular graphic changes were separated by individual product and chronologically sorted. Each day of T&E the DA's for that particular date were distributed uniformily to schedule a balanced workload on each workstation. One day of real-world changes were performed for each day of T&E. DMAAC test personnel were responsible for capturing the statistical revision performance data and maintaining the T&E log.

Chart revisions were performed by superimposing over the printed litho containing the changes a previous cycle film positive that does not have the changes. With the hardcopy DA of the analysts' changes the operators were able to identify where each change occurred. For minor revisions the changes were simply marked on the previous cycle watercoat proof. Terminal procedure changes were generally conveyed directly from the DA's unless the change was major. In these cases the changes were drawn on an overlay and furnished to the compiler.

4.5 ELECTRON BEAM RECORDER

The test and evaluation and acceptance of the EBR by Synectics from Image Graphics, Inc. (IGI) took place during Phase I of the AAIPS effort. Preliminary acceptance was performed at the IGI manufacturing operation. Test and Evaluation was conducted at DMAAC/AD where the factory acceptance test was repeated and an 80-hour production environment test was performed.

During Phase II simulated full production for the AAIPS FLIP/AAFIF production included utilization of the EBR for recording the AAIPS products. The first objective of the EBR T&E was to assure quality consistency products are produced to meet a standard. The second objective was to determine the EBR's capability to accomplish the FLIP recording workload in a reasonable period of time.

To support the quality objective, Synectics strived throughout the life of the project to develop and validate comprehensive EBR film production training procedures and safeguards to assume product quality. Three types of quality standards were identified. Type I tests relate to the film processing method and associated standards of chemistry, densitometry, handling, etc. Data Content validity tests for proofing the graphic/text information by softcopy display or hardcopy review are of the Type II variety. Type III tests are allied to hybrid indirect medium measurement by an instrument known as the Neutral Test Package (NTP). The NTP is a previously validated mechanism that is employed as a total production training quality measuring device. The NTP embodies all quality related conditions including new film stations, film handling and processing procedures,

chemical, software, and EBR status as well as human intervention arising from all activities performed in the past production train. Further, Synectics created a "Phased Joint EBR/EBR Film Quality Control Procedure" (reference Figure 4-1) employing all three types of quality safequards which were to be faithfully adhered to during the Phase II T&E period.

For a number of reasons the EBR film quality test objective could not be authentically established during the Phase II T&E. These reasons included:

a. lack of established film product standards;

b. unscheduled film processing routines;

c. oversized film processing units;

d. inappropriate film developing chemistry;

e. improper film orientation during film processing; and

f. failure to exercise the NTP as agreed upon in the Test Plans and Procedures.

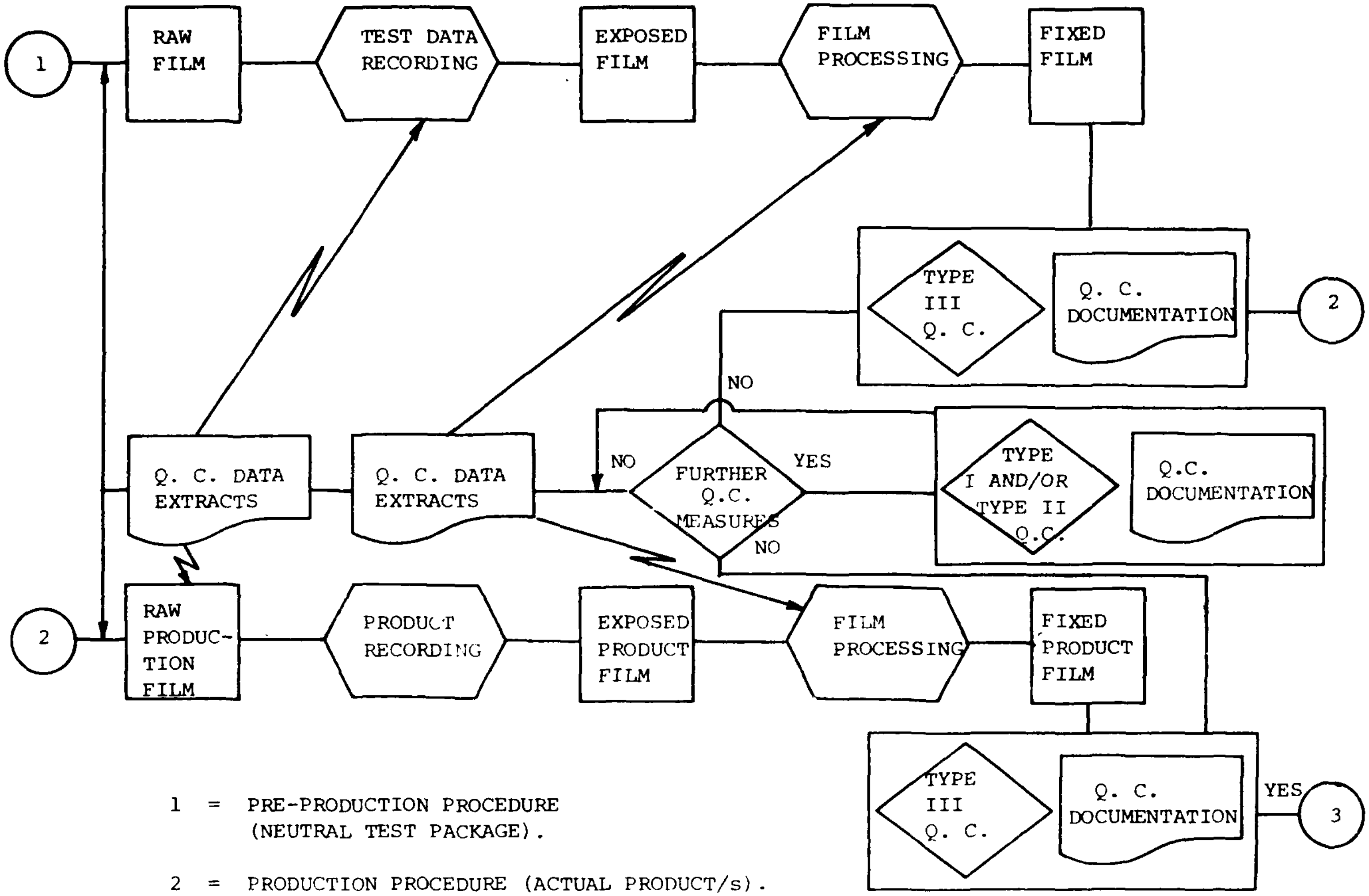
Also the medium prescribed for final quality evaluation as called for by the test scenario was the processed fixed original EBR film product. Unfortunately access to the original film was precluded by other express needs of the Government. The only recourse was in the form of later generation paper replicas which may mash or obscure film quality as well as distort minor film defects. All quality assessment during the T&E tests was subjectively derived from the paper surrogate products. The impact on film product quality resulting from the combined set of circumstances described above could not be directly ascertained.

EBR recording performance data revealed acceptable throughput results. In spite of the high speed writing speeds inherent in the EBR, overall throughput is heavily affected by system constraints such as the control processor, memory size, disk transfer rates, software and capacity of the vacuum system. The latter constraint is imposed by the duty cycle of the vacuum pumps which limits throughput to a miximum of 60 frames per hour. Nevertheless, EBR recording times (non-archival) for the FLIP products were quite satisfactory as follows:

a. 21 minutes/enroute chart;

b. 4 minutes/terminal procedure;

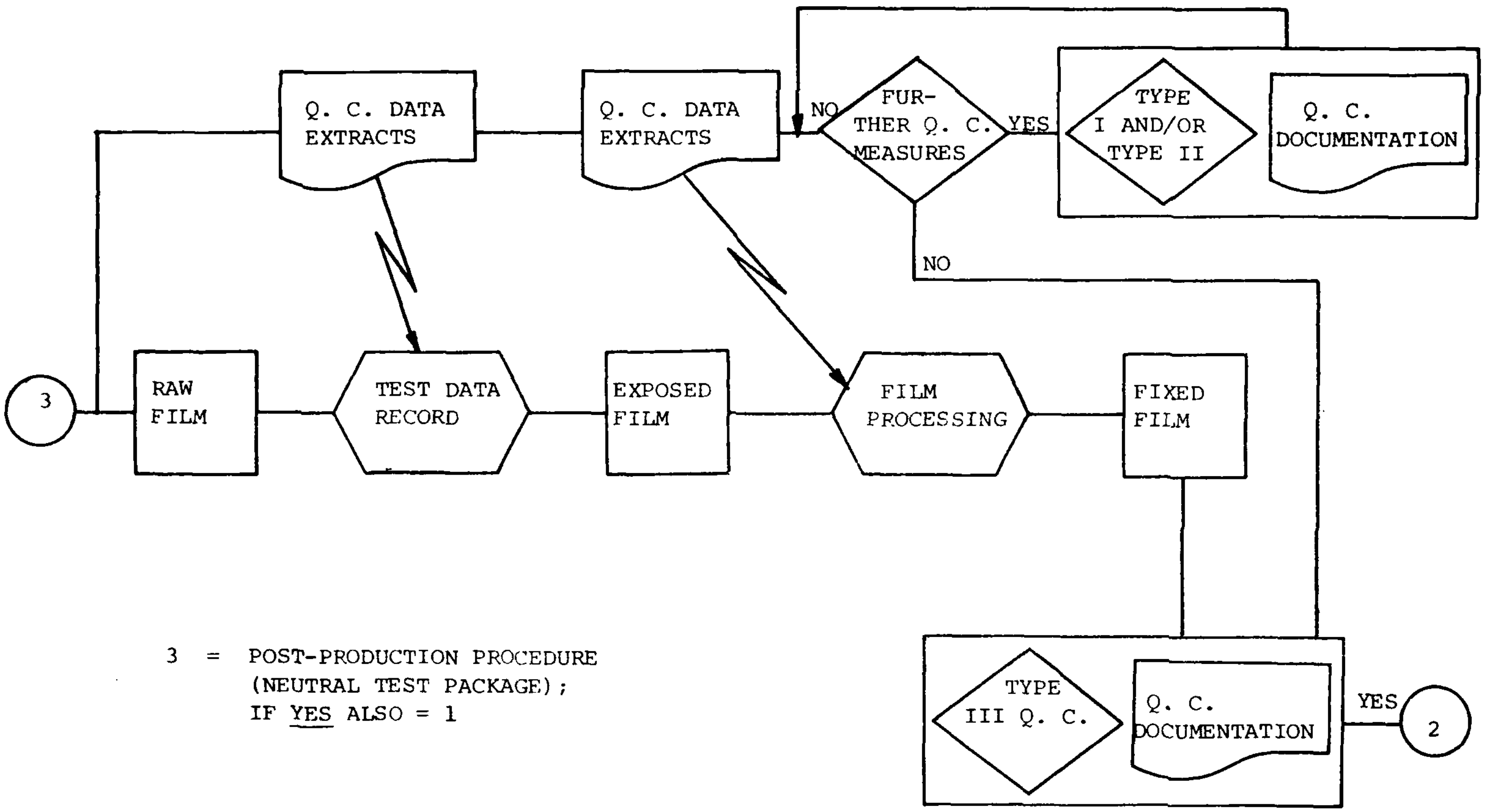
c. 2.5 minutes/supplement page;



1 = PRE-PRODUCTION PROCEDURE (NEUTRAL TEST PACKAGE).

2 = PRODUCTION PROCEDURE (ACTUAL PRODUCT/s).

Figure 4-1. Phased Joint EBR/EBP Film Q.C. Production Cycle (Page 1 of 2)



3 = POST-PRODUCTION PROCEDURE (NEUTRAL TEST PACKAGE); IF <u>YES</u> ALSO = 1

Figure 4-1. Phased Joint EBR/EBR Film Q. C. Procedure Cycle (Con't)
(Page 2 of 2)

d. 3 minutes/planning document pages; and

e. 4 minutes/VFR supplement page.

Problems encountered during the T&E directly attributable to the EBR anomalies included rare occurrences of text lines randomly misplaced within a page of text. Also evidences of occurrences of residual magnetism which can distort beam positioning were occasionally spotted. This problem relates to the current state of the art and is not currently remedial.

SECTION 5. CONCLUSIONS AND RECOMMENDATIONS

5.1 GENERAL

The Automated Air Information Production System (AAIPS) as designed, implemented and tested at the Defense Mapping Agency Aerospace Center (DMAAC) Aeronautical Information Department (AD) meets or exceeds the performance requirements for the automated production of high quality and timely Flight Information Products. This also includes the redesign of Automated Air Facility Implementation File (AAFIF) and providing the capability for on-line interactive data base maintenance and AAFIF product generation. The AAIPS implementation included all the hardware, software, procedures, and test data bases defined in the Phase I AAIPS Design Plan and later augmented during Phase II by a design revalidation based on the pilot system test and evaluation results and a complete analysis of the FLIP and AAFIF full production requirements.

The conclusions and recommendations for the future AAIPS transition into full production are described in this section. Our conclusions are based on the results of acceptance testing and our intimate experience with the system throughout the three years of developmental activity.

Certainly our perception of the needs of the system today is clearer than when the original AAIPS SOW specification was developed over three years ago. The recommendations advocated in this section address particular improvements to the AAIPS operational procedures to ensure success during transition to the production environment. Longer range recommendations that include certain hardware reconfigurations and upgrades are stated from the multiple vantage points of advances in technology and awareness of shortfalls in the provision for adequate backup capability in the original contractual system architecture.

Finally, it is our opinion that DMAAC/AD needs to be postured to anticipate future trends in technology and requirements and to be prepared to respond to their emergence by assessing system impacts and planning compatible solutions.

5.2 CONCLUSIONS

Based on the evaluation of the test and acceptance data during the Phase II development period the resulting conclusions can be made relative to the AAIPS performance.

5.2.1 Charting Subsystem

The capability to satisfy the full production workload including the product maintenance and EBR output preparation was confirmed.

The procedures for interactive revision of the product data bases proved to be extremely efficient. Throughout the T&E period the collective proficiency of the operators improved resulting in steadily declining average revision times. It was discovered also that revision throughput times were invariant of product type. Although the mix of T&E revisions had greater percentage of complex features the average revision time was about 5 minutes per feature. Elapsed wall clock times including all aspects of system - related functions, display generation, and hardcopy proofing were included in the revision throughput times. It was noted that over 20% of the interactive revision time is used for graphic display. Indeed during Phase II the CRT display software was modified to permit an improvement in display speed of from 20% to 40% over the original pilot software performances. Also during Phase II the message printout throughput for the interactive audit trail was improved. The original printouts were prefaced by a brief but frustrating delay. The messages are now printed immediately and provide a satisfactory prompting for the operator to continue the next operation.

Another improvement to the interactive revision capability was implemented during PHASE II to greatly simplify the procedure for making straight lines either "true" horizontal or vertical. This capability was especially beneficial to the data capture process for the enroute charts.

Although the procedures for performing interactive revisions are acknowledged to be very human factor oriented, there are some items worthy of improvement. For example, area symbols with minor subarea "cut outs" must be deleted and redigitized if a subarea boundary is to be changed. Since the frequency of this type of change is very low, the overall revision throughput is not adversely effected. However, performing this type of edit is cumbersome and frustrating for the operator. Similarly, the procedure for text revision requires the original text feature to be deleted and the new text to be re-entered. Fortunately, text entry and positioning may be accomplished on the Charting Subsystem very efficiently. Nevertheless, the graphic FLIP products contain a large amount of text (especially the enroute charts) and text features are associated with a high incidence of change. This indicates that a better procedure for text editing would contribute to even greater revision throughput.

Evaluation of the graphic test data produced in conjunction with the Phase II T&E revealed the need for the establishment of production proofing procedures. Numerous occasions of spelling errors, wrong font selections, improper data positioning, incorrect line weights and symbol selection, text justification and size lapses, and differential font leading were exhibited throughout the graphic data base. The presence of such data errors was not construed as a deficiency of the subsystem. Rather neglect on the part of the test personnel to exercise the error suppression mechanisms available in the form of hardcopies derived from FLIP specifications and operating experience contributed to the high incidence of data errors. The failure to correct the data deficiencies was evidence that production quality control procedures were not observed

The error-free quality and throughput performance of the EBR preparation software (EBRDC) was proven acceptable to support full production. Successful and timely conversion of the product drawing files to EBR output tapes requires that EBR preparation activities be carefully scheduled.

While data base maintenance of all product directories is a perpetual activity throughout the product cycle, the bulk of the EBR film recording is accomplished 3 weeks before the actual ICOD date. Interim-archival EBR preparation during the second and third weeks reduces the processing burden at the ICOD. The final-archival EBR

preparation updates all products to be published on the ICOD and only images that have changed since the first week of the current AIRAC need to be EBR recorded. The three modes of EBR preparation are explained as follows:

a. Non-archival - reprocesses all drawing file data and generates all new image data on the EBR output tape;

b. Interim-archival - reprocesses only color/screen separations that had changed since the last run and merges these with images copies from the last archival EBR tape; and

c. Final-archival - similar to the interim-archival mode but also flags all images that have not changed since the last non-archival run so they will not be recorded by the EBR.

The EBR preparation software and the graphic product directories are transportable between the Charting and Publishing Subsystems. Typical non-archival run times are 45 minutes and 5 minutes for enroute charts and the terminal procedures, respectively. Interim-archival times of 10 minutes per chart and 4 minutes for the procedures were experienced during the T&E period. The final-archival times were slightly better and averaged 8 minutes/chart and 4 minutes/procedure.

The net effect of the EBR preparation strategy is to balance the workload over the 28-day cycle and to minimize the backlog at the ICOD for both the Charting Subsystem and the EBR. The EBR preparation processing workload was projected based on the T&E average throughput time as applied to the worst-case FLIP production schedule. The evaluation results predict that the Charting Subsystem can effectively support the FLIP full production on a three-shift per day/five day per week basis.

5.2.2 Publishing Subsystem

The Phase II test and evaluation results confirmed the capability of the Publishing Subsystem to completely support full production. Certain software modifications to the pilot software were provided during Phase II to improve the human interactive responsitivity. These included the following:

a. Additional INFORMER CRT display information to indicate the current Datagraphix CRT cursor position (in half pica) and the total number of characters on the current page;

b. An improved scrolling capability which may be invoked in conjunction with the repeat (REPT) key and other Datagraphix keyboard keys. This permits a continuous forward or backward scroll by either a line or word at a time. Scrolling is performed only on the current page;

c. Airfield Retrieval by name (minimum of first 4 characters) for publications indexed accordingly;

d. Variable leading (positive or negative) to override the default leading;

e. Proof listing improvement to enable lower-case line printer output and to optionally bypass embedded non-printing text composition commands;

f. Footnote characters and the words they are associated with are treated as single non-hyphenated units;

g. Disable certain keyboard keys that could inadvertantly cause a termination to the Publishing interactive software; and

h. A pervasive "HELP" function to assist new operators may be invoked at any query/response mode in the interactive display.

The improved product revision capability proved to be very efficient as evidenced by the average revision times experienced during the T&E period. Typical revision times were 6 minutes per planning document change and 3 minutes per supplement revision. Applying these results to the worst-case full production FLIP schedule indicates that the publication revisions can be completely supported on a single-shift operation basis.

One of the major goals of Phase II was to improve the throughput time of the EBR Preparation/Repagination software. The improved software was capable of throughput performance six times greater than the original pilot software. During T&E the dual terminal mode of operation (dual concurrent processing) revealed a 30% overall throughput improvement over the single terminal mode. The T&E results also revealed that the archival repagination processing mode was approximately 10% slower than the non-archival mode. However, the archival mode conclusively proved its effectiveness in reducing the EBR recording workload at the ICOD date.

The assessment of the ability of the Publishing Subsystem to support full production throughput was based on the worst-case FLIP full production schedule. The most effective procedure for accomplishing the production workload is to perform a pre-ICOD non-archival EBR preparation (repagination run on all publications scheduled for the ICOD after all but the last week of revisions have been made). The post-ICOD archival run will then minimize the EBR recording burden since only pages that have changed during the last week will have to be recorded after the ICOD. The projected workload for the Publishing Subsystem including residual EBR preparation for the Charting Subsystem can be accomplished on a two-shift operation during the first three weeks of the 28-day cycle and on a three-shift basis for the last week.

It is apparent that the cooperative utilization of the three processors of the Charting and Publishing Subsystem provides more than adequate capacity to support the worst-case FLIP full production requirement.

5.2.3 Air Facilities Subsystem

The capability to support the full production workload which includes maintenance of the AAFIF file and scheduled and non-scheduled tape and report generation of products derived from the AAFIF file was verified.

The hardware configuration to support the remote terminal communications and the full AAFIF file proved to be fully responsive to the AD environment.

The AAFIF data base redesign proved to be both economical in disk storage and fast in terms of retrieval time. The complete AAFIF file and its multi-level indexes resides on three disk packs.

The interactive data base maintenance capability has been shown to be very well human-engineered and efficient. The air information analysts (AIS) found the system to be easy to use and averaged 2.5 minutes per element update during the T&E. This represents a 300% reduction in time as compared to our original design plan estimate. The response times at the terminals were very acceptable to the users, which indicates that a successful combination of system hardware/software and data terminal equipment was achieved. The subsystem will easily accomodate the AAFIF maintenance on a single shift basis.

The AAFIF applications programs output processing performance was successfully demonstrated during the test and evaluation. These programs will be scheduled for execution during the second and third shifts in order not to interfere with the interactive data base maintenance.

Prior to running the output processing, a daily card image and mini file maintenance job stream must be performed. These auxiliary files must be updated prior to the output production.

The capacity of the Air Facilities Subsystem to support the ASSOTW report generation and the other scheduled and non-scheduled tape and hardcopy reports was derived from extrapolation of the T&E results for the AFFUPDT, AFFINDEX, ASSOTW, and HTAPE program performance relative to the full production volume.

The Phase II effort was a major challenge. First a completely new computer system was acquired and installed. Software on the C-330 was predominantly programmed in FORTRAN-IV and the operating system RDOS, a relatively simple foreground/background monitor. The M-600 has a sophisticated multiprogramming operating system (AOS) which presented a "quantum-leap" in capability. The pilot interactive software was transported to M-600 and converted to FORTRAN-V, a faster and more efficient language than FORTRAN-IV. The goal was to maximize the legacy of the pilot software while not compromising the flexibility and performance of AOS. Another complication was the inherent differences in the file-oriented data base software (INFOS) as implemented under RDOS and AOS.

There were a number of items identified during the pilot T&E that required corrective action. First, logic checks after the complete entry of a new airfield or an update to an old airfield were performed inefficiently by the pilot interactive software. The logic check would check all elements in the airfield whether or not they had been updated and would stop on the first occurrence of a logic failure. The new interactive software was improved to perform logic checks on only elements that are logically related to the updated elements and all failures are flagged. Also the diagnostics indicate the name of the logic table which detects each failure and the AIS is able to more quickly ascertain this error.

The second improvement involved the airfield add function. The AIS was not able to edit previously entered elements on the current airfield being added, but rather was forced to sequence through each category until the whole airfield had been entered. Only after the airfield was completely defined would the AIS be able to return to correct known data entry errors. Further, the AIS could not log-off with the new airfield in a partial state of completion without having the airfield purged by the system. The Phase II software was improved to permit the AIS to edit and verify a category/subcategory after performing the initial data entry and prior to sequencing to the next category/subcategory. The AIS can log-off and return at a later time to continue building a partially complete new airfield. The airfield does not become a part of the data base until a full, extensive logic check is performed to verify that the new airfield is logically valid and complete (includes

all prime elements). The logic checks for an updated element were also made efficient. Typically the AIS will perform a number of element updates to an airfield. At the time when the AIS installs the airfield, logic checks are performed on all updated elements. The logic check involves the elements that were updated.

An airfield add by batch card input capability was also provided. This allows a card deck of airfield record data to be keypunched off-line by clerical personnel. This contributes to more effective utilization of the terminals and better use of personnel resources.

The card deck is processed by a two-pass operation. The first pass performs a format check to null elements to detect syntax errors. A diagnostic report would be printed and returned to the AIS for correction. Having passed the format checks, the second pass performs a full extensive logical check on all elements. Again a diagnostic report is printed for the AIS for review. The AIS may then perform all required corrections interactively at the terminal until the new airfield can be installed.

Another interactive software improvement was to distinguish between three types of airfields: (1) US; (2) Foreign Freeworld; and (3) Airfields having runways less than 2000 feet and/or unused runways. The reason for the distinction is that depending on the airfield type, certain elements may be ignored or certain elements may be computed. It was felt that machine editing/data entry should be streamlined for the AIS so the user would not be forced to enter irrelevant elements (depending on the type of airfield being updated). The interactive software now displays only the relevant elements depending on the airfield type. The AIS need be concerned only with element information that is displayed. However, the AIS has the capability to override the default display mode and display/modify all elements in the airfield if it is so desired.

Other interactive improvements included a better text editing capability which permits only the data entry of valid printing characters. Each softcopy display screen is appropriately marked with a security banner. The UTM coordinates of the airfield were computed by the interactive software and incorporated during Phase II. The interactive dialog was improved by providing clear and simple instructions. The display copy option was removed from the interactive menus and replaced by a positive feedback report mechanism. The AIS can select either a full airfield or a partial category/subcategory printout as desired. The print is spooled and printed later in the day and returned the following day to the AIS. The printouts are sorted by analyst code which facilitates distribution.

A much improved security log-on capability was provided. A time limit on each CRT after log-on is invoked for idle utilization. After 5 minutes of activity the master console operator is advised of the

condition and takes whatever appropriate action is required including terminating the session if necessary. The password system was revised to permit each AIS to have a respective password. Further the AIS is permitted access to only airfields tagged with country codes and WACs that are affiliated with this unique analyst code. In this manner, the integrity of AAFIF is assured. Three successive failures by an AIS to access an airfield within the geographical area of interest carries a warning message to be reported on the master console for the system operator to take appropriate action. Most important is that data base security is provided to assure that the airfield information will be maintained exclusively by the AISs for only the areas for which they alone are responsible.

A major capability to perform data base retrieval by interactive parameter selection was provided during Phase II. The special retrieval permits an area search to be performed on the AAFIF file in which multiple areas can be selected by specifying geographic cover coordinate limits and/or sets of WAC cell ranges. Boolean expressions involving unlimited combinations of data base elements and their conditional values (content) and logical relationships provide the extraction criteria. The retrieval produces a "hit" file of airfield record keys. The resulting "hit" file of airfield record keys may be used by any applications program to retrieve the airfield records matching the search criteria. The Boolean retrieval is used in conjunction with Special Air Information Request (SAIR) processing. It is an interactive function and requires a Boolean logic table to be constructed prior to invoking the search.

The Phase II effort required the AAFIF file structure to be redesigned based on the undesirable throughput performance experienced with the pilot subsystem. The resulting INFOS data base structure is flexible in terms of permitting data element growth and file expansion. The Phase II AAFIF file was designed for efficient disk space utilization and currently the 45,000 airfield records and indexes reside in their entirety on three 192M byte disk packs. The design also optimized airfield record retrieval time. Special INFOS interface software was written to permit an entire subcategory of data elements to be accessed at one time with minimal disk accessing and completely transparent to the applications program using the interface software. A FORTRAN INFOS interface module was developed to preserve the legacy of the interactive software which logically accesses a single element at a time. Similarly programming new AAFIF applications programs is facilitated by the availability of a COBOL interface package which permits the programmer to have the same logical view of the data base as the AIS user. The applications programs need not be concerned with the physical storage structure of the data base. The interface software permits an entire subcategory of data elements to be accessed at one time transparently to the applications program. The COBOL interface provides a mechanism to protect the applications programs from evolving data base changes.

Schema/Subschema element definitions are maintained for each subcategory in a common COPYLIB library for utilization by all applications programmers.

An on-line data dictionary provides a means to define and manage the data base schema/subschema structure. The data dictionary permits AIS users to review the logical content of the data base. The data base administration is facilitated by the data dictionary in respect to being able to manage data base changes. Evolutionary change is broadcast to the AIS users as an integral part of the data base maintenance operational procedure. Special software to automatically reconfigure the data base for the addition, deletion or modification of element definitions is provided. Software has also been provided to automatically move air facilities installations to new countries, reassign analyst code responsibilities to different country code and WACs, and to handle country code changes.

SAIR/DAIR processing is facilitated by the availability of the Boolean/Geographic Retrieval, SORT facility, AAFIF Mini file, and the RPG language processor. The data base retrieval "hit" file contains airfield record keys which can also be utilized to access information from the auxiliary files (i.e., Card Image file and Mini file). Alternatively, the Mini file can be searched directly by means of a simple COBOL program or by appropriate setup of the SORT utility. Most SAIR/DAIR quick reports can be derived directly from the mini file information. A SAIRSORT program is provided to permit mini file records to be sorted on any desired sequence of mini file elements. The output is a simple AOS sequential file which can be input to an RPG program hardcopy printing or tape output.

The interactive data base maintenance software automatically maintains a transaction log of all valid element additions, deletions, and modifications to the AAFIF file. Similarly element updates having significance to the ASSOTW report are recorded in an ASSOTW log file. The transaction log is actually two files (1) for fixed elements and (2) for variable text fields. The transaction log has many purposes including:

a. primary input to the AFFUPDT program which generates the DIA transaction tapes;

b. provides a trigger for generation of the analyst's positive feedback reports;

c. transactions are inputs to special software for updating the Minifile and Card Image File; and

d. transaction log provides backup in the event the data base files are destroyed and must be restored from earlier versions. A data base recovery program which merges the transaction log back to a particular point in time equal to the last good version of the saved data base is provided for this purpose.

A major hardware integration milestone was achieved with the successful checkout of the remote communications link between the M-600 facility in Building 3 and the 10 terminals in the secured vault in Building 4. During the development effort and throughput of the T&E period the high speed (56K bps) link would intermittently go out of synchronization. The problem was aggravated by a defect in the terminal communications firmware. The Datagraphix-132B PROM memories were subsequently upgraded by the vendor and the loss of synchronization occurs very infrequently. The KG-34 Encrypt/decrypt equipment has no diagnostic panel to assist the isolation of the troublesome fault. Lack of filtered clean facility power in Building 4 may be part of the problem. The line synchronization can easily be restored in minutes and fortunately the data base is not violated when communications are cut off. However, the annoyance can lead to frustration on the part of the AIS users because they are required to log-on again before resuming their data base maintenance.

In summary, the Air Facilities subsystem provides DMAAC/AD with a powerful on-line data base management capability with a wealth of software support tools to develop AAFIF applications programs and to provide the necessary capacity for meeting changing future requirements.

5.2.4 AAIPS Cartographic Electron Beam Recorder

The AAIPS EBR which was developed under subcontract to Synectics by Image Graphics, Inc. achieved the performance expectations as specified in the Acceptance Inspection and Test Procedures and which were verified by acceptance testing during Phase I effort. As such the EBR has proven to be quite capable of outputting high quality Flight Information Products for the AAIPS automated production environment. The EBR recording versatility permits all of the AAIPS printed documents (including the ASSOTW report) to be generated in a cost-effective manner.

The EBR product quality test and evaluation results were less than the quality levels inherent in the film, the software, EBR, and associated AAIPS hardware. However, establishment of optimal film processing standards which include correct size film processor units, film development chemistry recommended by KODAK, proper film orientation during the film processing, and exercise of EBR film quality safeguards (including the Neutral Test Package) should alleviate the film quality debasements. These discrepancies were definitized in the AAIPS Final Test Report, Volume V, Test and Evaluation.

The AAIPS EBR recording throughput capability as applied to the worst-case workload proved to be marginally acceptable. The projected EBR utilization throughout the 28-day cycle would be 77% of full capacity. This workload included the recording of all FLIP products for both Charting and Publishing subsystems and the ASSOTW production for the worst-case AIRAC cycle. The high utilization of the EBR is based on the recommended strategy of reducing the backlog of EBR recording on the information cutoff date by performing a full non-archival recording run on all FLIP products earlier in the cycle. The price of leveling the workload backlog is an overall greater amount of EBR recording. However, in order to ensure all FLIP products can be printed and distributed by their effective dates, leveling the burden on the EBR is mandatory.

5.3 AAIPS PERFORMANCE

The Automated Air Information Production System (AAIPS) as developed, implemented, and tested at the Defense Mapping Agency Aerospace Center (DMAAC) Aeronautical Information Department (AD) meets or exceeds the performance requirements for the automated production of Flight Information Products and Maintenance and Exploitation of the AAFIF file.

In assessing all of the results of the AAIPS system it is apparent that the technology required to successfully complete the effort covers a wide spectrum within the DMA R&D program. The AAIPS stands as a movement attesting to the wisdom of compiling the management and technical expertise fostered within the R&D environment with outstanding cooperation and support from the end user agency to successfully develop a cost-effective and highly responsive production system.

5.4 RECOMMENDATIONS

The recommendations identified herein are essentially short-term in nature and are primarily focused on rectifying certain encumbrances within the current AAIPS operational environment to ensure complete and satisfactory transition of the AAIPS into successful full production operation.

The realities of the environment surrounding the AAIPS is that change is inevitable. A perpetual assessment of the effectiveness of operational procedures, personnel utilization, production management, quality control, and system maintenance is an inherent responsibility of management. As with any system employing state of the art technology in hardware and software it is imperative that the user be alert to take advantage of new technology when it becomes expedient to do so. It is incumbent upon the user to master the technology available to achieve

optimal performance and to recognize deficiencies requiring remedial correction or replacement.

The recommendations perceived by Synectics are based on a relatively limited view of the operational AAIPS as provided by the test and evaluation exercises. For this reason the list below is by no means complete.

a. Comprehensive FLIP Proofing and Quality Control

The Phase II T&E demonstrated the need for a quality control procedure to be established and enforced by production management during the capture and revision of the FLIP product data bases. Although the error suppression mechanisms such as proof listings and CRT hardcopies are barely adequate the evidence of the T&E suggests they were never employed.

In the case of the Publishing subsystem neither the CRT softcopy display nor the upper/lower case printer can accurately portray the layout conditions, font style and size, justification, setwidth or variable loading of the text products. Proofing is limited to ascertaining the correctness of the textual content not the esthetic graphics art quality condition.

The enroute charts of the Charting subsystem defy adequate proofing by means of the small format TEKTRONIX hardcopy unit. Full scale proofing is unavailable in the AAIPS as it is presently configured.

Synectics recommends that a large format proofing plotter of the electrostatic variety be acquired to support the proofing requirement for the FLIP products. This capability, in concert with effective quality control practices, will minimize operator-induced data errors from contaminating the EBR film masters by permitting early detection and corrective action prior to EBR preparation.

b. Achieve Film Quality Procedures

A competent organization should be engaged to design procedures for all film aspects in the AAIPS production train. It is obvious that to avoid latent image decay (which is an oxidation effect) on unprocessed recorded imagery the SO-219 film must be processed as soon as possible after recording. The film density diminishes most rapidly in the first four hours after recording. Therefore, on-site film processing is recommended.

c. Exploit the Continous-Tone Properties of SO-219 Film

Kodak Direct Electron Recording Film, SO-219 is a continuous-tone film emulsion Estar base. It was specified to record the wide range of density levels required to achieve the various half tones in the end paper products. The recording of high contrast (maximum density) images which is the present method employed is compatible with the film processing procedures in the DMAAC photo laboratories. However, the generation of an EBR film positive for each color/half-tone screen separation uses a maximum of film and increases the number of film processing/compositing steps. Synectics recommends that the original EBR film post-processing strategy as specified in the AAIPS Design Plan be pursued. The approach suggested that continuous-tone positives be recorded by combining certain combinations of half-tones on the same image. Each half-tone would be associated with a particular density level (gray shade). Preliminary experimentation during the pilot phase showed promising results by recording 100% features and 120 line pairs/millimeter half-tone screened features together while recording the 200 line pair/millimeter half-tone screened features on a separate image. The resultant enlarged continuous-tone negatives would be screened by either a 120 lpm or 200 lpm soft dot screen depending on the separation during the compositing stage. Experimentation with the time of exposure while screening to achieve the optimal compromise would be necessary. The large cost-savings potential and time reduction that this approach promises are compelling reasons for renewed experimentation.

d. Acquire an Additional EBR to Ensure Adequate Backup

Overall mission success of the automated production of Flight Information Products depends heavily on the reliability of the EBR. It is particularly critical that the EBR be available for use at all times during the last week of each 28-day cycle and three days following the information cut-off date. Despite projecting an acceptable margin of EBR throughput capability against the worst-case production workload considering a 90% system availability, there is a high degree of risk

associated with a single EBR operation. No matter how redundant the spare parts inventory is and how competent and responsive the maintenance support staff is, there are undoubtedly certain circumstances of hardware failure that could cause unacceptable downtimes contributing to the missing of a handoff date to a publishing contractor. Should the EBR fail critically during the post-cutoff period, there would be a high probability that the FLIP products could not meet their effective dates of issue. For this reason the acquisition of a duplicate AAIPS Cartographic EBR system is recommended. IGI suggestions for incorporating an improved beam deflection yoke, higher capacity vacuum system, and an all-digital Symbol/Vector Generator should be seriously considered.

e. Record Matrix of Microimages for Text Products

The pure text publications are recorded at 100% density and are excellent candidates for microimage recording (i.e., 16 or 32 up). The payoff would be in film savings and less film handling in subsequent film processing steps. Investigations should also be conducted to determine the feasibility of microimage recording for graphic chartlets including IAP's, SID's, and airfield diagrams.

f. Assure Clean Facility Power

At various times throughout the contract performance period adverse power conditions were experienced in the AAIPS facility. A competent organization should be engaged to study the problem and recommend corrective action to assure the availability of clean power at all times. The study should include the synchronous communications difficulties experienced with the remote communications link connected to the data terminal equipment in Building 4.

g. Enhance Subsystem Applications Software

A number of software improvements have been noted in the conclusions section of this report. These items address obvious areas for improvement as experienced and reported to Synectics by ADA personnel tasked with the responsibility for operating and maintaining the subsystem. Without

doubt as ADA users become much more familiar with the subsystems this list will grow. At the same time, internal AD needs and external product requirements will add their toll to the growing list. The greatest challenge of the AAIPS as the system transitions into full production lies within the capacity of the ADA system analysis and programming staff to manage change. With good software engineering discipline, realistic support from management, and reasonable requirements and time frames, productive software improvements can be accomplished. Without careful analysis of proposed software changes and their impact on the overall subsystem the AAIPS subsystems performance could deteriorate to a point where capabilities would be rendered useless. This is always the risk when an extremely complex software system and the responsibility for maintaining it is transferred from the developer to the end user.

5.4.1 AAIPS Subsystem Hardware Reconfiguration

Throughout the contract performance period the development team has worked steadfastly toward implementing the system as it was originally specified in the design plan during the early stages of Phase I. Three years have passed since the original design was prepared and in that time technology has advanced and our collective understanding of the AAIPS operational requirement has been refined. Realizing that the processing workload is not shared equally across all three subsystems, some hardware reconfiguration should be considered. The concepts presented here involve a minimal cost solution while maximizing the legacy of the considerable software investment in the current AAIPS. The benefits of the reconfiguration presented below are:

a. Improved Charting Subsystem Throughput and Reliability;

b. Publishing Subsystem Backup;

c. Improved Air Facilities Subsystem Throughput and Backup; and

d. Improved Proofing of FLIP Products.

5.4.1.1 Physical Integration of the Charting and Publishing Subsystems

The proposed Charting Subsystem reconfiguration would involve a distributed architecture with a centralized host; each workstation would be a distinct processing entity independent of the other workstations and the work. Each work station would be supported by a satellite processor connected in a point-to-point mode with the ECLIPSE S-230 host processor (Reference Figure 5-1). This distributed architecture offloads the burden of the interactive station software from the S-230 processor to the station satellite processor thereby freeing the S-230 for other processing. Each satellite processor has its own local mass storage for operational software and temporary drawing files, symbol files, etc. Each station would normally operate independently of the host thus providing greater system reliability in the event of a host processor failure.

Synchronous communications lines between the host and each satellite would be used for down loading temporary drawing files to the stations or reforming revised drawing files to the host master data base. Backup for the communications link is provided by the presence of a comparable removable disk storage unit on the host.

The architecture permits ease of modular expansion. Additional satellite stations can be incorporated with minimal extra burden on the host processor.

Each S-230 host processor would be upgraded with synchronous line multiplexors and communications chassis. The memory of the host processor would be expanded to 256K words to permit operation of the Data General Advanced Operating System (AOS). A 10-megabyte disk cartridge subsystem consisting of one removeable 5-megabyte cartridge and one 5-megabyte fixed cartridge would be provided on the host. This would provide an alternate means for transmitting data files to/from the host/satellite processors. An additional Datagraphix CRT with the Publishing character set and two INFORMER V301 monitors and 4-line asynchronous line multiplexers would be incorporated on the host processor.

Presently the AAIPS has 4 Datagraphixs terminals processing the Publishing character set (i.e., 2 DX-132B's on Charting and 2 DX-132A's on Publishing). These terminals could be reconfigured on the two Charting Subsystem host processors for minimal cost. Two additional V301 monitors would be purchased.

The host processor would be capable of operating under either AOS or RDOS. For example, under RDOS all of the Publishing software and the Charting post-processing software could be processed with no software conversion necessary. Under AOS the binary synchronous communications (BSC) device drivers would perform the host/satellite communications. AOS also provides an excellent software development environment for new applications programming. Eventually, the portions of the Publishing and

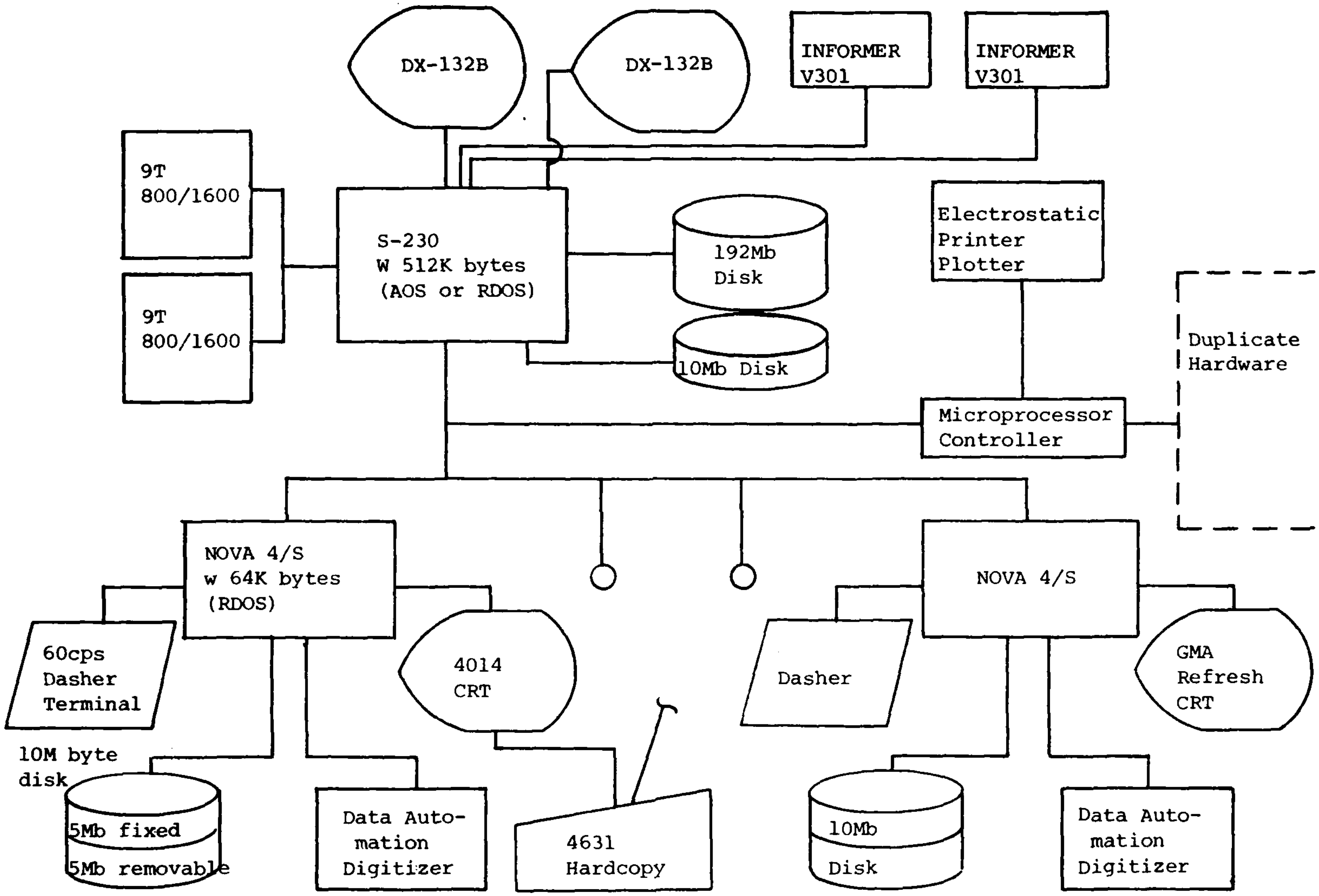


Figure 5-1. Integrated Charting/Publishing Subsystem Configuration

Charting software could be converted to AOS but this could be done gradually.

A large format electrostatic printer plotter with a microprocessor controller and integral vector-to-raster conversion capability would be connected by a communications line to each S-230 host processor. Proofing of FLIP graphics and text products would be completely accommodated.

Each satellite station would be supported by a Data General NOVA 4/S processor with 32K words of memory and 10 megabyte disk cartridge subsystem. A synchronous line multiplexor would be incorporated to permit communications to the host. Each NOVA 4/S would support a single workstation consisting of current AAIPS Charting Subsystem hardware including a Dasher terminal printer, Data Automation digitizer and Tektronix 4014-1 CRT. The NOVA 4/S supports RDOS and the interactive Charting Subsystem software can be directly transported to the NOVA 4/S with no software conversion required. The RDOS Communications Access Manager (CAM) supports binary synchronous communications (BSC) to permit communications to the host processor. Synectics recommends that at least one workstation be provided with a Tektronix GMA 102A CRT. The GMA CRT would have storage and refresh graphics capability, highspeed vector/character generator, and an interface to the 4631 hardcopy unit. The GMA CRT would be interfaced to the NOVA 4/S via a highspeed DMA interface permitting data transfer rates of 2 megabytes per second. The workstation having the GMA CRT would be used primarily for revision of enroute charts where the need for fast display throughput is critical.

The proposed reconfiguration of the Charting and Publishing subsystems has many benefits as summarized below.

a. The Publishing Subsystem is completely supported by two processors (i.e., S-230 hosts). Thus 100% backup of the Publishing Subsystem is accomplished with minimal hardware and virtually no extra software cost. The ECLIPSE C-330 processor would also be completely available for other processing.

b. The complete independence of each satellite workstation assures greater system reliability. Further schedule conflicts between interactive processing versus EBR post-processing is eliminated. Three-shift per day workstation operation would be permitted. Thus greater revision throughput is possible.

c. The S-230 host processors freed from supporting the workstations on a real-time basis have more time available for other processing. Some of this extra time will be for supporting the Publishing

requirement. The remaining time will be available for accomplishing the FLIP EBR post-processing workload, which can be performed concurrent with the satellite workstation processing with no interface.

d. Additional satellite workstations can easily be incorporated with minimal burden to the host processors. Thus system expansion to accommodate growth of the FLIP production or to add extra stations to reduce operations to a two-shift or single-shift basis can be accomplished with minimal input on the current architecture.

e. The merging of text and graphics for EBR preparation would no longer require the tape handling required in the current system. All Publishing and Charting subsystem product data bases would co-reside on the same mass storage medium.

The concept proposed above is not just a hypothetical approach. Synectics is developing a system at RADC for the DMAHTC with an almost-identical configuration. The Advanced Cartographic Data Digitizing System (ACDDS) will be in operational production in 1981. The ACDDS is an advanced architecture version of the Lineal Input System currently in operation at both DMA centers. The special hardware interface between the NOVA 4/S and the GMA 102A CRT and the graphic CRT device handler software is being developed under the ACDDS contract. Further, the binary synchronous communications protocol software to support the point-to-point communications between the host and satellite processors will be available under the ACDDS contract.

The ACDDS also features state-of-the-art voice recognition and scanning cursor technology which would also be of considerable interest to DMAAC/AD. Some of the ACDDS NOVA 4/S processors will be equipped with a microprocessor-based electronic speech recognition system. The Threshold Technology 500 terminal has a 64 word vocabulary which can be increased by expanding memory. The speech processor provides visual feedback of each spoken word that is recognized by means of a 16 alphanumeric character LED display. The voice entry capability allows the operator to enter feature descriptions and command data without interrupting vision or concentration by keyboard entry.

Other satellite stations will have direct plug-in microprocessor-based scanning cursors. The ACDDS digitizer table vendor, ALTEK Corporation, is manufacturing a scanning cursor comprised of a 100 X 100 photo diode matrix and angle digitizer. This cursor will allow trace

digiting rates three times greater than conventional cursor; it will alsO cause less fatigue on the part of the operator because the tracing is computer-assisted and much less tedious than with conventional methods.

The Aeronautical Department is well advised to track the development of this new technology and to take advantage of it when it becomes available.

5.4.1.2 Upgrading the Data General ECLIPSE C-330 Processor to Share the Air Facilities Subsystem Output Processing Workload

The physical hardware integration of the Charting and Publishing subsystems would free the C-330 processor for other processing. One possible use for this additional processor would be to offload some of the output processing from the Air Facilities Subsystem. Performing tape verification and copying would be one useful application. Another significant tactic would be to transfer the Card Image File and its associated processing to the C-330. Further there could be considerable advantages to having dual AAFIF data bases. The AAFIF file residing in the M-600 would be maintained interactively on a daily basis as per usual. A second AAFIF file would reside on the C-330 and would be updated daily via the transaction log residing on the M-600 after the AIS transactions were completed. Both data bases would be content equivalent and both processors could be used to generate the AAFIF tape and hardcopy production.

The C-330 processor, unlike the M-600 would be capable of operating under both the RDOS and AOS operating systems. Experience with both the RDOS and AOS versions of the INFOS data base software has been that indexed sequential access method (ISAM) file processing throughput is greater under the RDOS INFOS. It is currently believed that the Card Image File tape output processing (HTAPE program) could realize a possible throughput improvement of 25 to 50 percent under RDOS. Thus, the motivation to provide backup for the AAFIF output processing and to improve the overall throughput of the Air Facilities subsystem is the principle reason for upgrading the C-330 processor.

The hardware reconfiguration (Reference Figure 5-2) would require a memory expansion on the C-330 from 256K bytes to 512K bytes, which is minimum memory requirement for AOS. A 2M byte fixed head disk for swapping least recently used memory pages is also recommended to facilitate the AOS multiprogramming flexibility. A Dasher terminal printer would also be required by AOS for the system monitor console. Since the C-330 would be heavily utilized for tape copy and validation processing, the magnetic tape hardware would be expanded. A dual 7-track magnetic tape drive subsystem should be acquired to permit 7-track tape duplication and also provide a measure of redundancy. Similarly, an additional 9-track switch-selectable (800/1600 bpi) magnetic tape store drive should be acquired to expand the 9-track capability to a dual drive subsystem. Since the processor may support a maximum of two tape

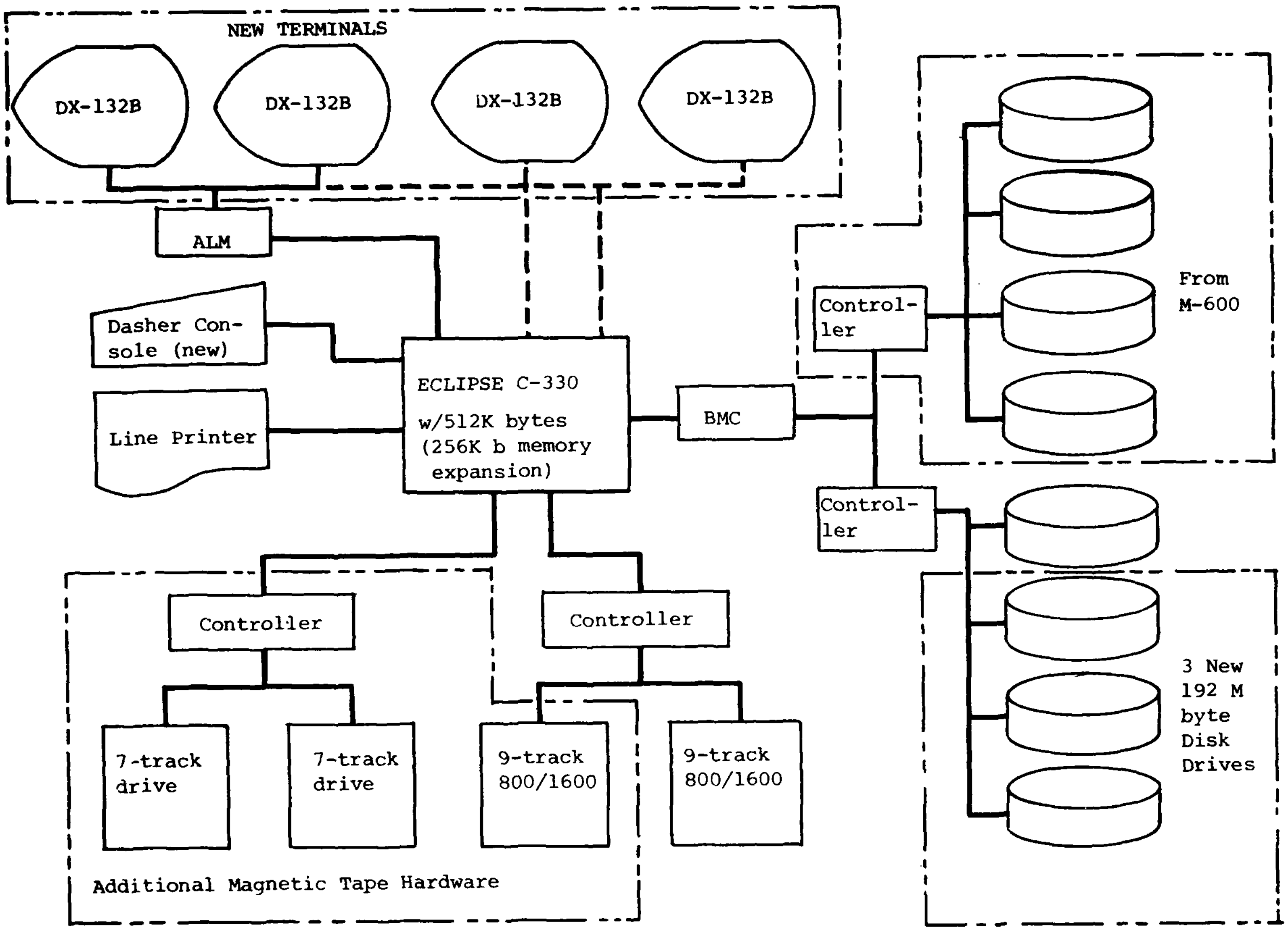


Figure 5-2. ECLIPSE C-330 Configuration Expansion

controllers the Wang 9-track 1600 bpi tape drive and controller would necessarily be removed from the C-330. The disk sybsystem of the C-330 would be expanded to a total of 8-192M byte disk drives. Although Data General Corporation now has a 300M byte disk, the ability to transport disks between the M-600 and C-330 processors would not be possible if the large capacity drives were acquired. Since the Card Image File would no longer be resident on the M-600, four disk drives and a disk controller from the M-600 would be installed on the C-330 processor. Thus only 3 additional 192M byte disk drives would need to be acquired. They would be installed on the disk controller currently supporting the single disk drive on the C-330. A burst multiplexor channel (BMC) is also recommended to support the disk controllers and to permit greater disk I/O throughput.

The number of Datagraphix 132B terminals that would be acquired depends on the amount of programming and Air Facilities related traffic expected to be performed on the C-330. A minimum of four CRT's is recommended. A 4-line asynchronous line multiplexor that is currently available on the C-330 could support a total of 4 CRT's with no expansion to the current communications hardware necessary. An alternative consideration would be to configure two CRT's as foreground/background terminals to support RDOS in addition to having two CRT's connected to the asynchronous line multiplexor. Selection of the Datagraphix terminals as opposed to alternative alphanumeric CRT's is for complete compatability with Air Facilities software. The C-330 configuration would be capable of supporting the interactive data base maintenance activity to a limited degree in the event of prolonged down time in the M-600.

5.4.2 Long Term Recommendations

The AAIPS production capability will mark the achievement of a major milestone in the automated production of flight information. The availability of the AAIPS product data bases will stimulate great interest on the part of traditional users for more rapid and varied access to the AAIPS aeronautical information. The Aeronautical Information Department, which is primarily a service organization for DoD flight information users, must be postured to anticipate and react to external and internal user requirements created by the demand for new and additional products. These products may take the form of micrographics, video disks, or more traditional paper hardcopy. There will also be an unprecedented demand for both textual and graphic data to be transmitted in digital form in a near real-time response to user requests. For these reasons, DMAAC/AD must be continually prepared to assess related technology and to be sensitive to new technological developments as well as be able to identify potential future requirements.

In order to prepare for the future, Synectics recommends that in parallel with a review of future requirements an AAIPS impact analysis be performed. The areas of impact that would be most heavily effected by future requirements levied upon the AAIPS environment would be the data

base structures, user interfaces, system architecture, and product generation capabilities. The impact analysis would be a system-wide logistic approach in order that recommendations would be put forth reflecting the best overall solutions for upgrading the AAIPS.

The definition of user requirements would be the logical starting point for this analysis. Old and potential new users would be identified and classified according to their particular information needs. Possible user requirements impacting on the AAIPS might include:

a. remote on-line access to each of the AAIPS subsystem data bases;

b. integration of the data bases to support increasing access requirements;

c. electronic transmission of AAFIF products; and

d. electronic transmission of the FLIP textual and graphic products for remote facsimile hardcopy generation.

New and different product generation capabilities would also be identified. These could possibly include microforms of certain AAIPS products such as FLIP terminal procedure (IAP's and SID's) and the ASSOTW report. Improvements to internal product generation capabilities may also be required as a result of breakthroughs in related technology such as laser platemaking. It is conceivable that direct laser recording of final press plates by digital input of AAIPS product file information to a laser platemaking subsystem could some day alleviate the need for the EBR. Similarly, archival recording of AAIPS products by means of optical disk mass storage technology could become a requirement for those users with playback and softcopy display capabilities. Remote transmission of AAIPS information for airborne CRT display systems is another example of a long range requirement that would dramatically impact the AAIPS environment.

The availability of the varied AAIPS flight information in manipulable digital form will undoubtedly beget an unprecedented demand for new products in digital and multi-media formats. As user information requirements expand, DMAAC/AD will need to identify and evaluate new and applicable sources of information which, too, may be readily available in digital form for direct input into the AAIPS.

As these requirements surface, DMAAC/AD must be prepared to assess their impact on the AAIPS and determine how best to satisfy them within the framework of future system architecture, hardware/software technology, and data base holdings. Only then with a solid implementation plan will enhancements be smoothly integrated into the AAIPS production environment and will DMAAC/AD be able to confidently manage the changing future.

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